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HIGH DISPERSION SPECTROSCOPY ON TY Vir*

We present the detailed analysis of HD 103036 = TY Vir. We find that effective temperature, gravity and metallicity show that TY Vir is similar to red giants in halo type globular clusters and that variations of the atmospheric parameters are related to photometry.

TY Vir is among the brightest known examples of semiregular variable stars of the halo population. It belongs to the Kapteyn moving group (Eggen, 1978) from the kinematical parameters U = + 54 km/s, V = - 273 km/s, W = + 96 km/s and V_r = 233 km/s. Few stars like TY Vir are known. It has been analyzed by Leep and Wallerstein (1981) with Θ_{eff} = 1.17 and log g = 0.6. They have found it is very metal deficient : $[Fe/H]_{\odot}$ = - 1.9. Luck and Bond (1985) have found it is less metal deficient : $[Fe/H]_{\odot}$ = - 1.45 with Θ_{eff} = 1.19 and log g = 0.7. Such a difference between iron abundance determinations is related with the effective temperature determination, i.e. the choice of the T_{eff} calibration. However, the use of a T_{eff} versus (R-I) and/or (V-K) calibration is not easy to derive effective temperature, since from minimum to maximum light, R-I ranges between 0.75 to 0.67 correspond to T_{eff} = 4000 to 4200 K.

Although TY Vir is classified in the GCVS (Kukarkin et al., 1976) as SRd with a magnitude 8.00 to 8.32 and a corresponding period of ~ 50 days, the only extensive photometric observations published are those which Beyer (1937) obtained between 1924 and 1936, which indicates a highly irregular light variation, sometimes with a period of about 100 days but without a definite recurrent pattern. However, the U, B, V data suggest a cyclic variation of small amlitude with a characteristic time between maxima of the order of 20 or 30 days (Preston and Wallerstein, 1963). Eggen (1961) observed this star and concluded that the variation was erratic. However, a plot of Eggen's data is consistent with a 30 day cycle. Note that radial velocity measurements of TY Vir show no definite evidence of variability (Preston and Wallerstein, 1963).

*based on observations made at Observatoire de Haute Provence, France.

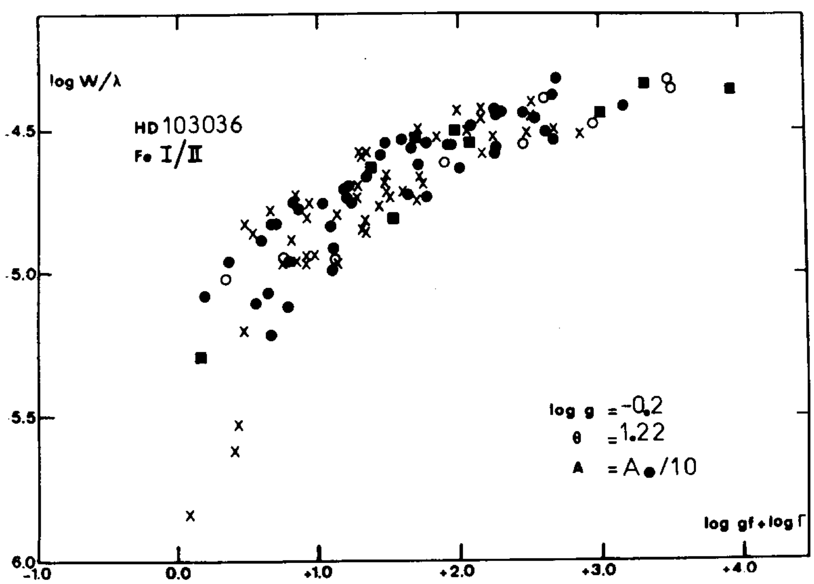

Figure 1

We have analysed in detail TY Vir in order to check its chemical composition, age and evolution.

The detailed analyses are based upon three high dispersion spectrograms taken with the Coudé spectrograph of the 1.52m telescope at Observatoire de Haute-Provence with a dispersion of 12.4 Å/mm and a mean resolution of 0.3 Å. They have been taken on baked IIaO Kodak plates. The reduction of the spectrograms has been made using the method of equivalent width measurements, the principles of which are given in Proust and Foy (1986). The atmospheric parameters have been partly deduced from the curve of growth analysis. For this purpose, we have used FeI and FeII curves of growth, since they are the best defined. We have computed model atmospheres from $T(\tau)$ relations homologous to those computed by Gustafsson et al. (1975) and Bell et al. (1976) for the most appropriate values of the effective temperature T_{eff}, gravity g and metal abundance A relative to the sun.

The effective temperature was obtained from the R-I(0.71) and V-K(3.10) colour indices, with the colour index versus T_{eff} calibrations of Johnson (1966) applied differentially with respect to the two well known giants, HD 113226 (ϵVir) and HD 122563. The gravity g has been determined as a function of T_{eff} from the ionization equilibrium criterion applied to iron.

From the deatiled analysis with respect to the sun, we deduce the following atmospheric parameters : θ_{eff}= 1.22, log g = - 0.2 $[Fe/H]_{\odot}$= - 0.95 ξ= 2.8 km/s^{-1}, ξ is the microturbulent velocity. Fig. 1 shows the iron curve of growth obtained for TY Vir.

The difference between our [Fe/H] determination and that of Luck and Bond (1985) can be accounted in the following way : we have reanalysed their equivalent width measurements using our model atmosphere and the atmospheric parameters they have derived : θ_{eff} = 1.19, log g = 0.7 and $[Fe/H]_{\odot}$= - 1.45. We have obtained $[Fe/H]_{\odot}$ = - 1.35, value which closely matches their determination. The 0.1 dex difference could be due to the differences in the differences in the input physics (abundance of electron donors), and to the scatter of the linear part of the curve of growth. Correcting this abundance for our lower θ_{eff} leads to $[Fe/H]_{\odot}$= - 1.43 (from the FeI curve of growth). But we have to restore the ionization equilibrium : this requires to adopt log g = 0.4. As a result, the iron abundance becomes [Fe/H] = - 1.37 with θ_{eff} = 1.22 and log g = 0.4. Gravity is always difficult to determine accurately. For hotter effective temperetures, large uncertainties in the gravity have little consequences on the abundance determination ; this is no more the case for stars as cool as TY Vir. We have also to keep in mind that TY Vir is an irregular variable, so that the photometric data used in the analysis should be acquired simultaneously with the spectrograms, Waiting for a more complete analysis, we will assume for the following discussion the compromise [Fe/H] = - 1.2.

We cannot explain the large discrepancy with the determination of Leep and Wallerstein (1981) in the same way ; their gravity determination is consistent with that of Luck and Bond (1985). The same discussion as above leads to decrease [Fe/H] by 0.04 dex ; this is much too small to get a value consistent with that of Luck an Bond, and a fortiori with ours.

TY Vir is classified by Eggen (1978) as member of the Kapteyn moving group from its kinematical parameters.It has been classified as a globular cluster like giant by Preston and Wallerstein (1963) from its location on the giant branch of M3, and also by Eggen (1978) using the U-B, B-V diagram of ω Cen.

The membership of TY Vir to the Kapteyn moving group would lead to an age of $10-12 \cdot 10^9$ years corresponding to the late halo population.

If we adopt an average absolute magnitude $M_v = -1.2$ (Eggen, 1978), our value of T_{eff} from the above analysis and evolutionary tracks (Vandenberg,1983) give the same age of $10 - 12 \cdot 10^9$ years. Note that the Kapteyn's star (HD 33793) has been analyzed in detail by Mould (1976) with $\theta_{eff} = 1.43$, log g = 4.87 and $[Fe/H]_{\theta} = -0.5 \pm 0.3$. This metallicity is close to our determination for TY Vir. Another star of the group, HD 44007 has been also analyzed in detail by Proust (1984) with a deficiency $[Fe/H]_{\theta} = -0.65$. From the point of view of the chemical composition, this group is real. Carrying on further these arguments would lead to the idea that stars like TY Vir could be escaped from globular clusters (Peebles, 1966). However a large increase of detailed analyses of stars like TY Vir as a function of phase will be a powerful tool : i) in the understanding of the variability processes and ii) for our understanding of the galactic structure and evolution.

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