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THE SPECTRAL TYPES OF THE SUPERGIANTS HR8752 AND ρ CAS

HR 8752 is one of the most luminous stars in our galaxy. Recently it has been the subject of a large number of studies: Piters et al. (1988) have studied its atmospheric structure, stellar wind and binary characteristics properties; Sheffer and Lambert (1987) have suggested from the analysis of radial velocity data the presence of a bimodal pulsation with possible periods of 421 and 315 days; Halbedel (1988) has discussed the most recent light variations and the $H\alpha$ structure. Regarding the light variations the star shows cyclic variations with a timescale of the order of 1 year (e.g. Mantegazza et al., 1988), and a slow trend of the (B–V) index to the blue which is steadily continuing since 1977 (Halbedel,1988, Sheffer and Lambert, 1987).

Zsoldos (1986) has tried to reconstruct the hystorical light curve of this object. According to him the star was fainter in the middle of the last century and then gradually brightened. This author has also reconstructed the variations of the star's spectral type (see Figure 1,+). The spectral type varies between F8 and G4. According to Luck(1975) in 1973 the spectral type could be as late as K3. However this estimate is not a classical MK determination, but it has been obtained both from the flux distribution and from the curve of growth analysis, so it is not sure that it could be compared with the other spectral estimates. Piters et al. (1988) have found from a model of atmosphere analysis of a spectrum of HR 8752 obtained in 1984, that different models such as T_{eff}=4000K with $\log g = -2$, and T_{eff}=5500 K with $\log g = 1.5$ can explain the atomic line spectrum equally well.

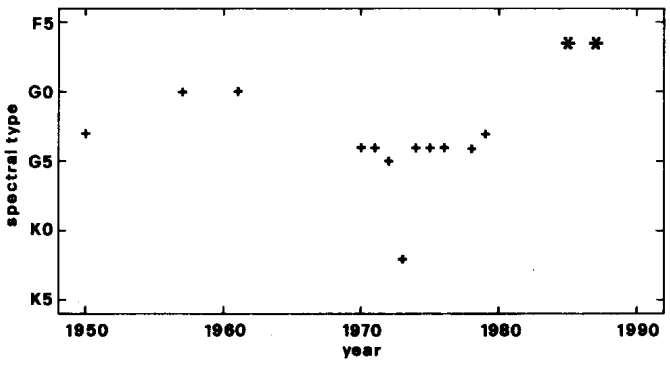

Figure 1

Two spectra of HR 8752 were taken on December 16,1985 and on September 22, 1987 with the Reticon detector of Brera Observatory (Bonanno and Falomo, 1988) at the 182 cm telescope of Asiago Observatory and at the 137 cm reflector of Merate Observatory respectively. In both cases a Boller and Chivens grating spectrograph was used. The spectra cover the region between 7500 and 9000 Å, with a resolution of 2.9 Å/pixel.

Since the spectra were taken in the framework of a programme for the study of the luminosities of intermediate supergiant stars, several standard stars were observed with the same equipment too. This allowed to derive quite accurate spectral types for HR 8752. Some criteria for determining spectral types in this spectral region have been given for example by Parsons (1964) and Bouw (1981). The two spectra of HR 8752 are quite similar and give a F6÷7 type, which is the earliest ever observed for this star. These two points are reported in Fig.1 as asterisks. From the figure we see that the spectral type is changed from the value of G3 which the stars had in the seventees to the present one of F6÷7. This is in agreement with the steadily decrease observed in the same period for the (B–V) index.

Another confirmation of this fact is given by the intensity of the OI 7774 Å triplet. In my spectra this line has the same equivalent width of 2.46 Å. Osmer (1972) who observed it in 1967 or 1968 found a value of 1.57 Å. Sorvari (1974), who measured this feature in his photometric index approximately in 1972, found a value that would correspond roughly to 1.7 Å.

The OI line intensity is linearly correlated with absolute magnitude for F supergiants, however for G type stars this intensity decreases sharply with the decreasing of temperature (see e.g. Sorvari,1974). This fact explains the differences in the equivalent widths. When the star was of spectral type G its OI line was much less strong than now. In fact if we compute by means of Sorvari's equation the luminosity of the star we get from Osmer's or Sorvari's equivalent widths $M_V \simeq -6.2$., a value too low for a Ia–0 supergiant. This only means that the equation is not applicable because the spectral type is too late. From my equivalent width we get, after the transformation of the equivalent width into Sorvari's index (Mantegazza, in preparation), M_V=–9.5, a value which is in good agreement with the –9.5÷–9.1 interval derived by Humphreys (1978) for this star on the basis of its membership in the association Cep OB1.

ρ Cas is a supergiant quite similar to HR 8752. Recent observations of its light variations are due to Halbedel (1988) and Leiker et al.(1988). Sheffer and Lambert (1986), as a result of their spectroscopic observations, have proposed that this star could pulsate radially with a dominant fundamental radial mode with period of about 520 days.

This star also shows variations of spectral type. According to Morgan et al. (1981) its spectrum has changed from F8 to G4. For this star too there are contradictory classifications according to the system adopted to determine it; here we will follow MK types (Morgan et al., 1981).

A spectrum of this star, with the same characteristics of those of HR8752, has been taken on September 16, 1987 at Merate Observatory. It looks quite similar to those of HR 8752, however it is definitely later and can be classified as F8. Therefore the spectral type of this star was F8 in the thirties, K0 in 1947, it went from G0 to G4 during the seventies and now it has returned to F8.

The only striking difference between the spectra of ρ Cas and HR 8752, apart from the small ones due to the slightly different spectral types, is the intensity of the FeI 8824 Å line, which for ρ Cas is more than three times stronger than for HR 8752. For comparison the adjacent MgI 8806 Å line has roughly the same intensity for both the stars.

Lambert et al.(1981) and Lambert and Luck (1978) have found that FeI 8824 Å line is highly variable in HR 8752, due to the presence of emission components which they assigne to the circumstellar shell. However in my two spectra of HR 8752, its intensity is quite similar.

The OI 7774 triplet has an equivalent width of 2.13 Å. The resulting visual absolute magnitude computed by means of Sorvari's equation would be -8.4. The corresponding luminosity is quite low if compared to that assigned to the star by Humphreys(1978) ($M_V = -9.5$) on the basis of its membership in the association Cas OB5. However this estimate is strongly dependent on the assumption that the interstellar visual absorption is 2.13 mag, which in turn was derived assuming a spectral type of F8 Ia. If we assume, as it is more reasonable, that the spectral type at the time of Humphreys' observations was G0 Ia, then A_V=1.53 and consequently M_V=-8.9. On the basis of different considerations Sargent(1961) derived for ρ Cas M_V=-8.4. A further indication that the luminosity assigned to the star by Humphreys is too high is given by Morgan et al.(1981): according to them in 1977 the luminosity class of HR 8752 was brighter than that of ρ Cas.

In any case this discussion bears into evidence how large are the uncertainties connected to the determination of absolute magnitudes of high luminosity stars and how necessary are further efforts to improve this situation.

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