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Spectrophotometric Observations of HR 8107

S. C. Joshi, D. K. Ojha & J. B. Srivastava *Uttar Pradesh State Observatory, Manora Peak, Naini Tal 263129*

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Abstract. HR 8107, a reported new Be star, has been observed spectrophotometrically. The energy distribution curve of the star has been compared with those of other stars of similar spectral and luminosity types and model atmospheres. On the basis of comparison with model atmospheres an effective temperature has been assigned to the star.

Key words: Be stars—energy distribution

1. Introduction

The star 8107 = HD 201836 B6 IV, $v \sin i = 120\ \mathrm{km\,s^{-1}}$) has been shown to possess a double peaked Hα emission feature, by Hirata *et al.* (1986) during their observations of the star on 1985 November 20 and 24. The *UBV* magnitudes of the star, measured on 1985 December 20 by the same authors, however, show that these were the same as observed on earlier occasions by several other authors. In order to study the behaviour of the star in the continuum we have observed it on 1986 November 11 with the help of a spectrum scanner.

2. Observations

The observations were secured at the Cassegrain focus of the 104-cm reflector of the Uttar Pradesh State Observatory. The spectrum scanner used for these observations has a dispersion of 70 Å $\mathrm{mm^{-1}}$ at the exit slit. We have used exit slit of 0.7 and 0.4 mm width corresponding respectively to about 50 and 28 Å bandpasses. Thermoelectrically cooled EMI 9658 photomultiplier and standard dc recording technique have been used.

The standard star ξ^2 Cet has been observed for converting the observed monochromatic magnitudes to standard values. The mean extinction coefficients for the season October–December, have been used for applying the extinction correction. The mean extinction coefficients are quite consistent, provided the night is seemingly good for photometric observations. This was the case for the night of our observations.

There are colour and spectral type anomalies in case of Be stars due to the presence of outer envelope, rapid rotation and inclination of rotation axis to the line of sight. The mean two colour relation adopted for B-type stars is not strictly applicable to Be stars. Methods based upon the distance modulus (Goraya 1986), or the strength of the interstellar absorption band at λ 2200 Å (Beeckmann & Hubert-Delplace 1980) have been proposed to determine the interstellar reddening correction for Be stars. We determined a $E(B-V)$ value of $0^{m}.16$ for HR 8107 through the method of the strength of λ 2200 Å band. It was, however, felt that there may be an uncertainty in determining the depth of the λ 2200 Å band as the UV fluxes at that wavelength showed large scatter. The reddening of HR 8107 has been given to be $0^{m}.14$ by Tolbert (1964). The average intrinsic colour of B6 type star given by FitzGerald (1970) gives $E(B-V) = 0^{m}.13$ for HR 8107. In the remaining discussion we have adopted $E(B-V) = 0^{m}.13$ for HR 8107. This value we believe is the smallest plausible value. The interstellar extinction curve given by Nandy *et al.* (1975) has been used to determine the reddening corrections at different wavelengths. Table 1 gives the reddening corrected monochromatic magnitudes of the star normalized to λ 5000 Å along-with the reddening corrections applied. The error of these magnitudes is estimated to be $\pm 0^{m}.04$.

3. Discussion

The reddening-corrected monochromatic magnitudes of HR 8107 have been displayed in Fig. 1. In the same figure we have plotted the normalized reddening-corrected magnitudes of 23 Tau = (HD 23480), δ^1 Tel(= HD 170465) and model atmosphere

Table 1. Monochromatic magnitudes of HR 8107 and the reddening correction.

λ (Å)	$1/\lambda$ (μm^{-1})	Mean m_λ	Reddening Correction (mag) $E(B-V)=0.13$	Normalized reddening-free magnitudes
3500	2.86	6.444	0.629	+0.488
600	2.78	6.460	0.600	+0.533
700	2.70	6.739	0.585	+0.827
800	2.63	6.241	0.574	+0.340
900	2.56	5.809	0.566	−0.084
4000	2.50	5.559	0.551	−0.319
100	2.44	5.570	0.540	−0.297
200	2.38	5.583	0.529	−0.273
300	2.33	5.641	0.520	−0.206
400	2.27	5.596	0.509	−0.240
500	2.22	5.618	0.501	−0.210
600	2.17	5.644	0.488	−0.171
700	2.13	5.688	0.476	−0.115
800	2.08	5.716	0.466	−0.077
900	2.04	5.765	0.455	−0.017
5000	2.00	5.769	0.442	0.0
100	1.96	5.808	0.436	+0.045
200	1.92	5.858	0.423	+0.108
300	1.89	5.860	0.416	+0.117
400	1.85	5.878	0.401	+0.150
500	1.82	5.878	0.397	+0.154
600	1.79	5.921	0.386	+0.208
700	1.75	5.888	0.373	+0.188
800	1.72	5.914	0.362	+0.225

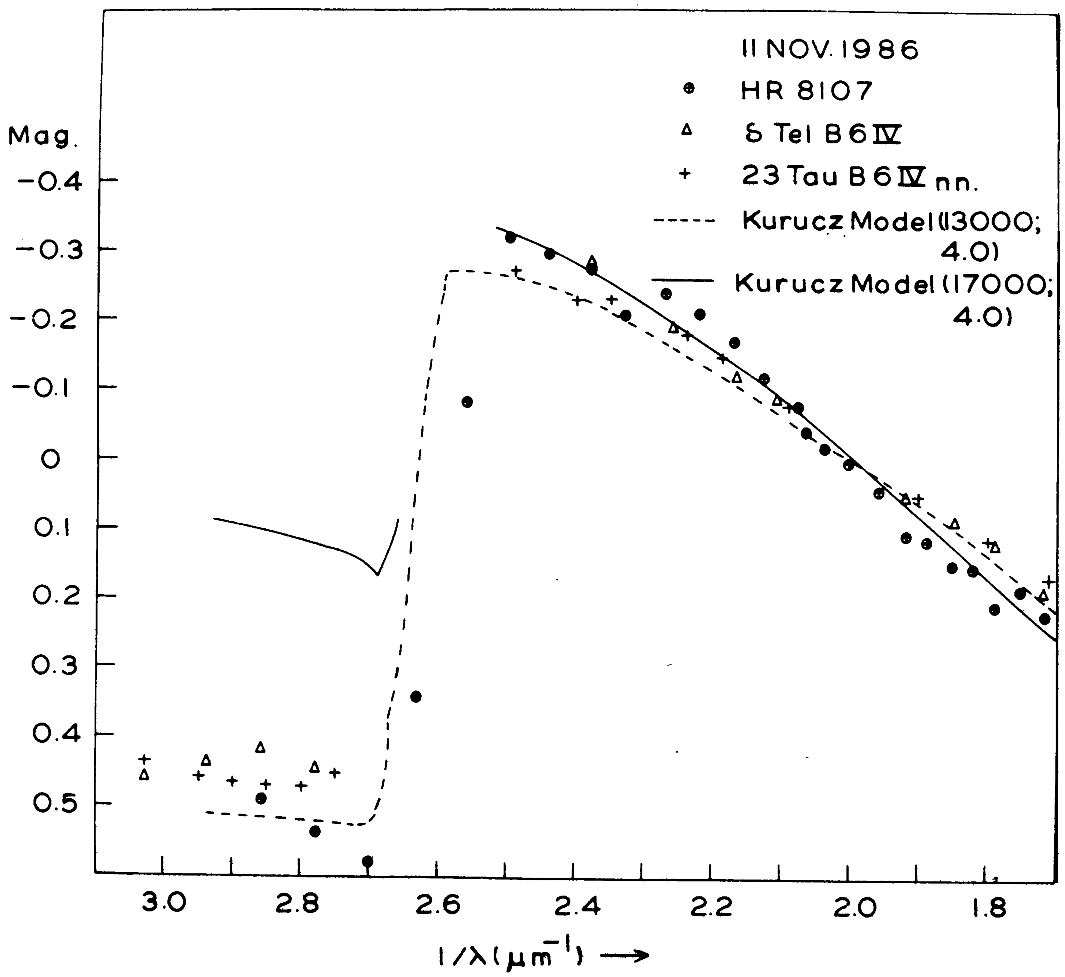

Figure 1. Plot of reddening-free (normalized at $1/\lambda = 2.0$) magnitudes of HR 8107, δ^1 Tel, 23 Tau, and model atmosphere fluxes for models 13000 K, 4.0 and 17000 K, 4.0 against $1/\lambda$.

fluxes for two models taken from Kurucz (1979). The stars 23 Tau and δ^1 Tel have the same spectral and luminosity class as HR 8107. 23 Tau is characterized by nebulous characteristics (Hoffleit 1982). Underhill *et al.* (1979) have given its spectral type as B6 IVe. δ^1 Tel is given as B6 IV (Hoffleit 1982). The monochromatic magnitudes of 23 Tau and δ^1 Tel have been taken from Breger (1976) to which reddening corrections corresponding to $E(B-V) = 0^m.10$ and $0^m.01$ (Jamar *et al.* 1976) respectively have been applied. For 23 Tau the $E(B-V)$ has been determined through the method given by Beeckmans & Hubert-Delplace (1980).

Fig. 1 shows that the Balmer continuum region of HR 8107 matches with the model $T = 13000$ K, $\log g = 4.0$ (dotted line) quite well. There is, however, discrepancy in the matching of the Paschen slope. The Paschen slope of the star seems larger than that of the model (13,000, 4.0). The Paschen slope matches with the model (17,000, 4.0) (solid line), but a large misfit beyond the limits of observational errors results when one attempts to match the Balmer continuum region.

Although Be star energy distributions are modified by the b-f and f-f emissions from the circumstellar envelopes, their contribution in the wavelength region 4000–5500 Å is quite small. This is evident from a good match of the Kurucz model atmosphere fluxes with those of a large number of Be stars (Goraya 1986). The departures from model atmosphere fluxes are marked in the region just shortward of the Balmer jump and beyond 5500 Å towards longer wavelengths. δ^1 Tel matches the model (17,000, 4.0) better in the region 4000–5000 Å but the match is poorer below the Balmer jump. 23 Tau matches the model (13,000, 4.0) reasonably well in the entire region of comparison.

3.1 *Temperature from Ultraviolet Fluxes*

We have also determined the temperature of the star, with the help of its ultraviolet fluxes taken from the Ultraviolet Bright-star Spectrophotometric Catalogue (Jamar *et al.* 1976). The fluxes have been dereddened corresponding to $E(B-V)=0.13$, in the same manner as used for the visible region fluxes.

Joshi & Rautela (1987) have determined the temperatures of B and Be stars using their UV fluxes and Kurucz model atmospheres in the appropriate range. It has been shown that for strongly active Be stars, the temperatures determined from the two spectral regions could differ considerably. The same procedure has been applied for HR 8107 to determine the temperature T_{UV}. We obtain a value for $T_{UV} = 12800$ K for assumed log $g = 4.0$.

HR 8107 has also been typed as B5 V (Blanco *et al.*, 1970). Assuming that the difference in the classification is real it seems reasonable to ascribe the changes in the spectral features due to the changes in the circumstellar envelope of the star. There are marked differences in the fitting of model atmosphere in the Paschen and Balmer continuum regions of emission B stars. The energy distribution curve of HR 8107 obtained by us behaves like HR 985, HR 9070, and HR 8682 given in Tur & Goraya (1988) and like BD + 15° 1176 and BD + 60° 180 given by Schild (1976).

The better fit of Paschen slope of the model (17,000, 4.0) with HR 8107 leads one to ascribe a temperature of 17000 K to the star; however, the temperature derived from the ultraviolet region is close to 13000 K. Joshi & Rautela (1987) have found differences in the temperatures derived from UV fluxes and the Paschen region fluxes. The difference can both be on the positive and negative sides. Since the emission activity is treated as weak during our observation, we ascribe a temperature of 13000 K to the star, so that the temperatures derived from UV and Paschen region fluxes tally.

3.2 *Scans around Hα Region.*

In Fig. 2, we have displayed the original but smoothed scans of HR 8107 in the region of the Hα line. Five scans of HR 8107 and one of ξ^2 Cet have been drawn for comparison. Though no clear evidence of the emission feature at Hα are visible at this resolution in the traces of HR 8107, there appears to be a filling in of the Hα line particularly in scans 3 and 4. In scan 3 a weak trace of emission spike is also visible.

4. Conclusion

A comparison of the energy distribution of the star HR 8107 with stars of similar spectral type (23 Tau, δ^1 Tel) shows that in the Paschen continuum region the slope of

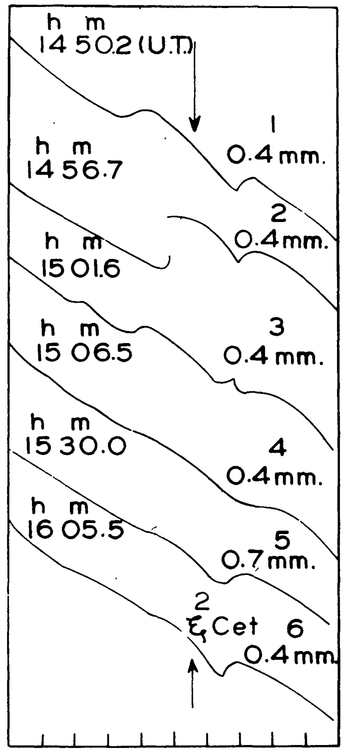

Figure 2. Smoothed scans of HR 8107 and ξ^2 Cet in the Hα regions.

HR 8107 is more than that of other stars, though in the region just shortward of Balmer discontinuity HR 8107 is closer to 23 Tau (another emission B6 IV star). A temperature of 13000 K has been assigned to the star.

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