DETERMINATION OF THE SPECTRAL TYPE AND LUMINOSITY OF THE HOT COMPONENT OF THE ECLIPSING BINARY STAR RZ ERI

V. G. Karetnikov, E. V. Menchenkova, O. I. Syrov
Astronomical Observatory, Odessa State University,
T.G.Shevchenko Park, Odessa 270014 Ukraine
E-mail: root@astro.odessa.ua

ABSTRACT. By using the spectra taken at 6m telescope and the methods of two-dimensional spectral classification, the non-ordinarity of the main star in RZ Eri is shown. The presence of the circumstellar gas and of the surface activity of the stars in a binary are suggested.

Key words: Stars: Eclipsing Binaries; Spectral Type; Spectral Criterion; Model Atmospheres.

According to Svechnikov's (1986) classification, the eclipsing binary star RZ Eri belongs to the class of DS-systems. These close binaries contain a subgiant secondary which does not fill its Roche lobe. RZ Eri is also a member of the group of the RS CVn-type stars which show emission lines H and K Ca II, presence of star spots and a solar-type activity of the surface layers. This object was studied many times photometrically and spectroscopically and shows a wide variety of short- and long-term instabilities.

Main absolute characteristics of stellar components and the system as a whole were determined by Burki et al. (1992) and Popper (1988). They are summarized in Table 1. Photometrically the system is characterized by a well pronounced reflection effect causing periodical brightness variation; by a well determined rotational period of the stars in a pair; by a long-period 1600^d oscillation of the nonstationary brightness variation. Secondary minimum in RZ Eri is shallow and is centered near phase 0.67. At the center of primary eclipse a brightness excess is observed which we explain by a light refraction phenomenon arising in the atmosphere of the eclpsing star.

Earlier Cesco & Sahade (1945) and Gadomski (1957) detected circumstellar matter. According to Burki et al. (1992), the color excess $E_{B-V} = 0.17^m$ describes light absorption in a circumstellar envelope with $A_V = 0.56^m$ and radius $r = 1800$ A.U. Properties of matter in this envelope and of the intelstellar matter are equal (Murray et al. 1990), what is also justified by a presense of the IR excess (Busso et al. 1990). There are circumstellar gaseous structures in this system which carry matter at a rate $M = 1.7 \cdot 10^{-11}\ M_\odot$/yr. Total mass loss at a subgiant stage is estimated as $2 \cdot 10^{-4}\ M_\odot$.

Separate interest is attracted to determination of the spectral type of the stellar components of RZ Eri. First estimates of Cesco & Sahade (1945) gave a spectral type $A5m$ for a primary, what was doubted. Later Popper (1988) estimated types as F5 V + K2 III-K2 V. Recently Burki et al. (1992) estimated spectral types as A8-F0 IV for a hot star and G8-K2 IV-III for a cold one. Temperatures of stars correspond to $\lg T_{eff,1} = 3.869$ and $\lg T_{eff,2} = 3.68$, for gravitational acceleration $\lg g = 3.75$ and 2.97, respectively. Divergence of results is seen which obtained by using different methods. Thus we decided to redetermine spectral types of stars based on our data.

The work was based on two difractional spectrograms of RZ Eri obtained on 28.08.1991 at the 6-m telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences with dispersions 9 and 28 Å/mm at phases 0.31 and 0.34. Spectrograms in intensities were digitized by an automatic photometer of the Crimean Astrophysical Observatory and redu-

Table 1. Parameters of the binary RZ Eri.

$P_0 = 39.28254^d$	$M_1 = 1.69\ M_\odot$
$T_0 = 2446048.883$	$R_1 = 2.79\ R_\odot$
$e = 0.377$	$M_{bol,1} = 1.40^m$
$\omega = -47.3^o$	Sp_1 = A8–F0 IV
$i = 89.30^o$	$P_{rot,1} = 2.4^d$
$A_V = 0.65^m$	$M_2 = 1.63\ M_\odot$
$r = 180$ pc	$R_2 = 6.80\ R_\odot$
$r_{env} = 1800$ A.U.	$M_{bol,2} = 1.45^m$
$t = 3.3 \cdot 10^9$ yr	Sp_2 = G8–K2 IV-III
$A = 72.52\ R_\odot$	$P_{rot,2} = 34.5^d$

ced by using the "SPE" computer code elaborated by S.G.Sergeyev. By using the tables of Griffin (1979) and Moore et al. (1966) the spectral lines were recongized. Their characteristics were determined by fitting the lines by a Gauss approximation.

For determination of the spectral type of the hotter star we used the method of two-dimensional spectral classification of Kopylov (1960). Results are presented in Table 2. Dispersion of estimated values is large within interval from A 5.3 – F 2.7. Mean value Sp_1=A9±3.

Determination of the spectral type of the primary star in RZ Eri was also made by using the method of model atmospheres. The shapes of the lines $H\beta$, $H\gamma$ and $H\delta$ were reduced by using the "Balmer" computer code. For effective temperature and gravitational acceleration we had obtained $\lg T_{eff,1} = 3.804 \pm 0.006$, $\lg g_1 = 4.4 \pm 0.3$. It may be noted that this temperature is by ≈ 1000 K lower than estimates made by other authors (cf. $\lg T_{ef,1} = 3.869 \pm 0.006$ in Burki et al. (1992)) and corresponds to a spectral type ≈F7 and a luminosity class ≈V.

From the characteristics of the hydrogen spectral lines the electron number density in the primary's atmosphere was estimated. By using the method of Unsold (1941) we obtained the following estimates: $\lg n_e(H\beta) = 14.09$, $\lg n_e(H\gamma) = 14.28$, $\lg n_e(H\delta) = 14.46$. Mean value $\lg n_e(H) = 14.28 \pm 0.15$. This value corresponds to a spectral type F7 V. Thus modeling the hydrogen lines only gives same spectral type F7 V which is much later than that estimated by Burki et al. (1992).

Analysis of the obtained results argues for a pecularity of the spectral type of RZ Eri.

Table 2. Spectral type estimates of main star in RZ Eri. (Criteria of Kopylov (1960) transliterated from Russian.)

Crit.	type	Crit.	type	Crit.	type
Zh	F 0.2	M	A 5.3	R	A 7.4
Z	F 0.3	N	F 2.2	S	A 7.1
K	A 7.8	O	A 5.8	T	F 0.6
L	F 2.7	P	F 0.5	H	A 7.5

By using criteria of Kopylov (1960), one may say that there are three "simultaneously coexisting" spectral types: A5.6 (2 criteria), A7.4 (4 criteria), F0.6 (4 criteria), and F2.4 (1 criterium) with a scatter ≈ 0.2 within a group. However, models of the hydrogen lines argue surely for F7 V. This characteristic is close to the Popper's (1988) estimate but does not agree with recent results of Burki et al. (1992). It is also distinctly outside the interval of the spectral types obtained from the same data by using other spectral criteria. Possibly we deal with distorsional influence of the circumstellar gas and of the surface activity of stars in the system RZ Eri. Further study is highly needed.

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