HIGH-RESOLUTION SPECTROSCOPY OF LONG-PERIODIC ECLIPSING BINARY ε AURIGAE

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ABSTRACT. The results of spectroscopic observations of long-periodic eclipsing binary ε Aur are reported. The observations were carried out during 2 nights in 2007 at 2-meter telescope located at the peak Terskol, Northern Caucasus (Russia). Here we present series of ε Aur spectra together with EW measurements of the most prominent absorption lines.

Key words: Stars: binary: eclipsing; stars: individual: ε Aur.

1. Introduction

ε Aur is well-observed long-periodic eclipsing binary, but still one of the most puzzling star. It is the eclipsing binary with longest known orbital period – 27.1 year. The main enigma is considered in the eclipsing object (it is supposed that the eclipsing body is of gigantic proportions, on the order of 2,000 solar radii). Its nature discussed for a long time, but still no reasonable explanation was given.

The eclipsing nature of ε Aur was first mentioned by Fritsch (1824), where he discussed first ever-observed minimum in 1821. Since that ε Aur' eclipses were observed each 27.1 years (Ludendorff, 1904) (in 1848, 1875, 1902, 1929, 1956, 1983), the next is expected in 2010 (first contact – Aug, 06, 2009; mid-eclipse – Jul, 09, 2010).

Recently (Carroll et al., 1991) ε Aur ***secondary*** was interpreted as a protoplanetary system. So, spectroscopic monitoring before and during the eclipse is of great interest.

2. Observations

Spectroscopic observations were done at the Terskol Observatory (Russia, Northern Caucasus) during two nights, particularly at March, 30-31 and March, 31-April, 1 in 2007. 2-meter Zeiss telescope and coude-echelle spectrometer was used. The wavelength range covers from 3660 to 9500 Åin 80 orders. The reciprocal dispersion ranges from 0.038 to 0.09 Å/pixel. The spectral resolution was R=45000.

3. Discussion

Our research was focused on searching for the short-time variations of $H\alpha$ line profile. $H\alpha$ line was detected in absorption together with prominent blue and red emission wings symmetrical one to another, which is quite exciting (see Fig. 1 for the plot of $H\alpha$ region of ε Aur spectrum).

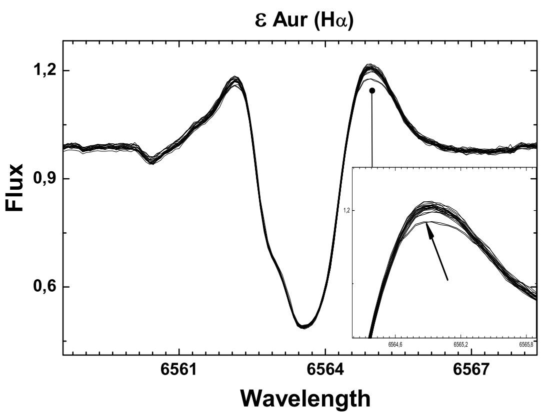

Figure 1: $H\alpha$ region of ε Aur spectrum during March, 30-31, 2007 observations

The value variations of equivalent widths (EW) of the blue wing, the red wing and the absorption core of the $H\alpha$ line profiles were calculated ($F/Fc > 1$ – emission, $F/Fc < 1$ – absorption) and given in Table 1.

EW was calculated by direct numerical integration over the area under the line profile.

As could be seen from Fig. 1, the blue wing of $H\alpha$ line underwent a changes during the course of observa-

Table 1: List of spectra and equivalent widths of components of ε Aur $H\alpha$ line.

No.	Exp. time, min	S/N	EW of blue wing, Å	EW of central absorption, Å	EW of red wing, Å
	30.03.-31.03.2007				
1	6	170	-0.145	0.647	-0.204
2	6	200	-0.154	0.645	-0.209
3	6	220	-0.155	0.642	-0.212
4	6	250	-0.155	0.644	-0.211
5	6	250	-0.151	0.645	-0.207
6	6	220	-0.155	0.643	-0.210
7	6	250	-0.158	0.640	-0.213
8	6	220	-0.156	0.641	-0.208
9	6	200	-0.157	0.64	-0.214
10	6	230	-0.155	0.642	-0.213
11	6	220	-0.155	0.644	-0.211
12	6	200	-0.154	0.642	-0.212
13	6	200	-0.156	0.642	-0.211
14	6	220	-0.154	0.642	-0.214
15	6	200	-0.151	0.644	-0.209
16	6	200	-0.153	0.645	-0.211
17	6	220	-0.148	0.646	-0.210
18	6	200	-0.154	0.644	-0.214
19	6	200	-0.152	0.645	-0.211
20	6	200	-0.145	0.645	-0.193
21	6	200	-0.147	0.645	-0.194
	31.03.-01.04.2007				
1	5	200	-0.157	0.648	-0.212
2	5	200	-0.156	0.645	-0.208
3	5	200	-0.155	0.649	-0.206
4	5	200	-0.157	0.647	-0.207
5	5	200	-0.154	0.645	-0.207
6	5	220	-0.155	0.648	-0.206
7	5	220	-0.155	0.647	-0.208
8	5	200	-0.156	0.646	-0.205
9	5	200	-0.155	0.645	-0.210
10	6	180	-0.156	0.646	-0.208
11	6	170	-0.155	0.648	-0.206
12	6	180	-0.153	0.649	-0.200
13	6	200	-0.160	0.643	-0.214
14	5	200	-0.155	0.650	-0.201
15	6	200	-0.152	0.653	-0.205
16	6	220	-0.157	0.650	-0.212
17	7	220	-0.152	0.654	-0.206
18	7	200	-0.149	0.655	-0.204

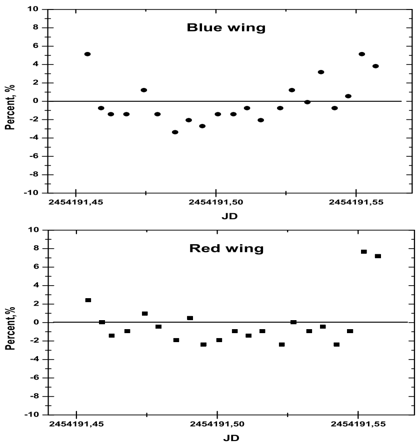

Figure 2: EW variability of $H\alpha$ during March, 30-31, 2007 observations

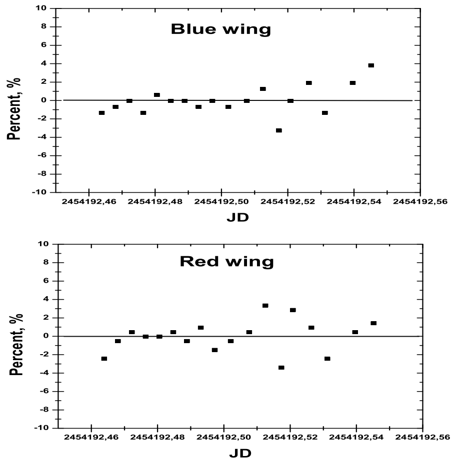

Figure 3: EW variability of $H\alpha$ during March, 31 – April, 1 in 2007 observations

tions at March, 30-31, 2007. This changes reach up to 8%, that could be considered to be significant. During the next night no changes were detected, reaching 5% limit (see fig. 2 and 3 for plot of EW changes in % during both nights).

Schanne, L. (2007) interpreted emission components of $H\alpha$ as evidence of gas behind the star (for red-shifted component) and radial outward flows, attributed to instabilities in the star (blue-shifted component).

Cha et al. (1994), Cha et al. (1995) attributed blue wing emission source to region region which contains an HII cloud with a short time scale variation.

Also EW of the following absorption lines all of which exhibit long-term variability (Thompson et al. 1987) were mesured: Fe I (3922.9 Å), Ti II (4028.0 Å), Ti II (4443.85 Å), Ti II (4468.48 Å), $H\beta$ (4861.5 Å), Na DI (5889.953 Å), Na DII (5895.923 Å), O I (7772 Å). No short-time variability, reaching 5% limit, were detected.

Fig. 4 illustrates several portions of ε Aur average spectra, with the most prominent lines being identified and denoted.

Further photometrical and spectroscopical monitoring of this object is critically important for understanding ε Aur – the most puzzling eclipsing binary.

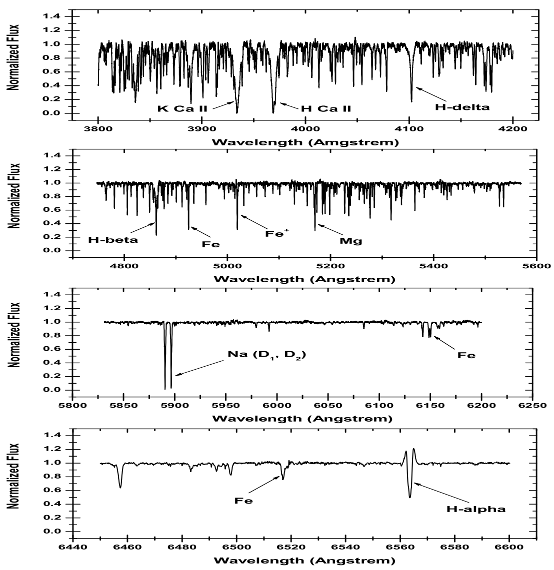

Figure 4: Portions of ε Aur average spectra, with the most prominent absorption lines being marked

References

Cha G. et al.: 1994, *A&A*, **284**, 874-882.
Cha G. et al.: 1995, *IBVS*, No. 4149.
Fritsch J.M.: 1824, *Berl. Jahrb.*, p. 252.
Schanne L.: 2007, *IBVS*, No. 5747.
Thompson D.T. et al.: 1987, *ApJ*, **321**, 450-458.