UNUSUAL CHANGES IN THE SPECTRUM OF AE HERBIG STAR HD 179218

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The results of homogeneous spectral observations of the Herbig Ae-type star HD179218, which were obtained in 2018 on the 2-m ShAO telescope with a spectral resolution of R=28000, are presented. The variability of the profiles and parameters of the H$\alpha - H\gamma$ hydrogen lines has been studied. The emission line $H\alpha$ is characterized by two absorption peaks and a central absorption. The ratio of the intensities of the blue component to the red shows variability with a characteristic time of $\sim$100 days. We confirmed our previous result, discovered for this star in 2015 on the smooth variation in the profile structure of the $H\alpha$ line. We assume that the observed phenomenon is related to the inhomogeneity of the circumstellar disk of the star.

Keywords: variables:Herbig Ae/Be–stars: circumstellar matter–stars: individual–HD179218

1. INTRODUCTION

HD 179218 (MWC 614, Sp B9-A2) is an isolated Herbig Ae (HAe) type star. The circumstellar surroundings of the star were studied by IR photometry and speckle interferometry by [5, 7], which did not reveal closely spaced components. Spectral studies of the star were performed by [9] and in more detail, in [3, 4].

According to the classification of [10], the spectral energy distribution (SED) of the star belongs to group I, i.e. starting with the infrared band K and further there is an excess of radiation excited in the dust. On the [11] the profile of the line $H\alpha$ is consisting of a stable single-peak structure. Perhaps the star has a close companion, about 2.5 arcsec apart [13]. I the work [1] showed that the star has two dust rings at distances of 1 AU and 20 AU, and the space between from 1 to 6 AU from the star filled with gas. The magnetic field of the star was measured by [6] where on the data 2008 they have got about 51 $\pm$ 30 G.

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Our previous studies of this star based on hydrogen lines were published in the work [12]. In this work, we discovered for the first time a wave-like variability in the parameters of the emission component of the $H\alpha$ line on a time scale of about 40 days. In addition, in our work, we have shown the appearance of additional emission and absorption components in the $H\alpha$ line profile, which gradually disappear at the time of the minimum. The aim of this work is to monitor the spectral variability of the star based on new observational data obtained in 2018.

2. OBSERVATIONS

The spectra were carried out in the 2-m telescope of Shamakhy Astrophysical Observatory of Azerbaijan National Academy of Sciences. We used ShAFES spectrographs that works with CCD $4K \times 4K$, spectral resolution is R-28000 in wavelength range λ3700- 8000 Å [8]. The mean signal-to-noise level is S/N $\sim$ 100 in the region of the $H\alpha$ line, and S/N = 40-60 in the region of the $H\beta$ line. Wavelength calibration have made on the sky and ThAr lamp spectrum. For calibration and processing of spectrograms used the DECH20T software [2]. The method of observations and material processing is described in more detail in the work of [12]. We used 10 pairs of spectrograms of the star for 2018 year. The mean error of positional measurements in the spectra of standard stars was 0.5-1 km/s, and standard deviations in intensities at 0.5%.

In the Table 1 is presented the log of observations, where in columns are respectively presented the names of the spectrum, Julian dates (JD) and the signal-to-noise ratio at the line $H\alpha$. Observations were conducted for the season May-August 2018. For to control of instrument stability and position measurements the spectra of standard stars for each night were obtained.

3. MAIN RESULTS

The line Hα

This line has a complex structure, which consists of an emission component that is superimposed on the core of broad photospheric absorption. The structure of the emission component varies from night to night, sometimes in both the red and blue wings of the line, additional emission components appear and disappear. In the Fig.1 shown all overlaying profiles of the $H\alpha$ line (solid lines), as well as the variation in the root-mean-square (r.m.s) deviation σ (dashed lines) from the average in intensity for a given value of the radial velocity. Here (and further for other line profiles) the ordinate is given by the ratio relative intensity I/Ic, where I - the intensity at a given wavelength of the spectrum, and Ic-the continuum

Table 1. The log of observations of the star HD 179218

JD 2450000+	Sp	texp (sec)
8240.620	KF2253-54	2700s
8276.346	KF2461-62	1920
8288.342	KF2484-85	2400
8294.406	KF2563-64	2400
8297.340	KF2648-49	2500
8327.283	KF3029-30	2500
8332.242	KF 3080-81	2500
8337.417	KF 3124-25	3000
8338.409	KF 3136-37	3000
8352.380	KF 3243-44	2700
8338.409	KF 3136-37	3000
8352.380	KF 3243-44	2700

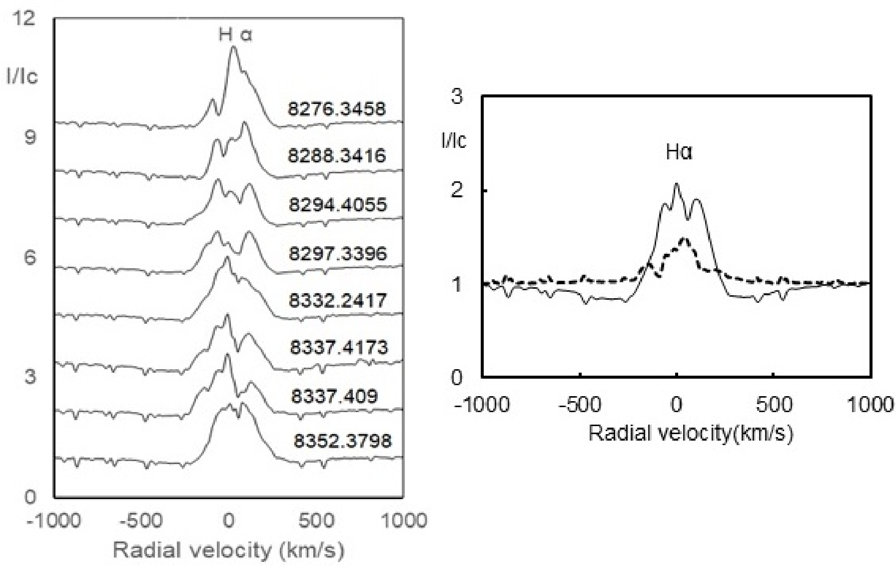

Fig. 1. All profiles, obtained for 2018 of the line $H\alpha$ (left panel). In right panel is presented average profile (solid line) and its standard deviation σ (dashed line).

intensity at the same wavelength. Hence it can be seen that the main variability in the central emission occurs at the peak, and also to a lesser extent on both wings. It is also seen that the intensity varied on the blue wing is noticeably larger than on the red wing.

As can be seen from Fig.1 in JD 2458276 the $H\alpha$ line has a weak blue emission component, which for next nights show a gradual increase in intensity. Simultaneously, the intensity of the red component gradually decreases. At the end of the season, for about 112 days, the profile of the line $H\alpha$ has the invers form with of the first date profile. In the right panel, rms structure σ of the profile is exhibit variability mainly at the red component and in weak form in the blue component. The same variability in the $H\alpha$ line profile we have observed in our previous work for the star HD 179218 9 (Ismailov et al. 2019). Such type profile variations in the $H\alpha$ emission line obtained in that work the same time was accompanied with variations of spectral line radial velocity and equivalent widths of the line in time scale at 40 days. In the Fig.2 shown the diagram of variations

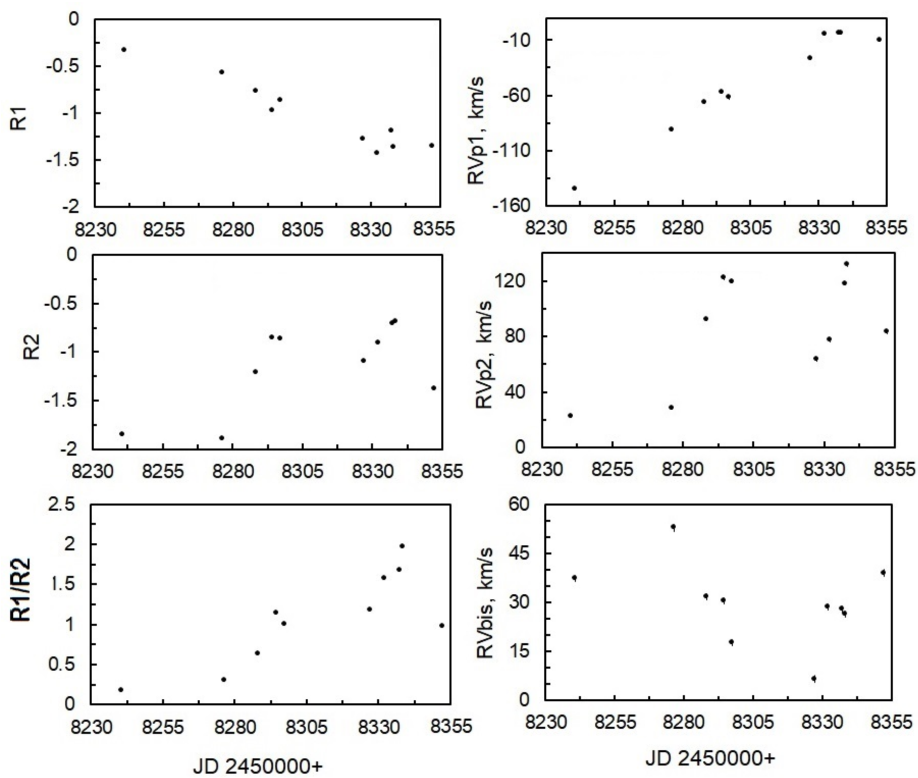

Fig. 2. Time variation of some parameters for the emission line $H\alpha$ and in 2018. From left to right, depths R1 and R2 and accordingly its radial velocities RVp_1 and RVp_2, and in bottom relative intensities R1/R2 of emission peaks and whole bisector radial velocity RV_{bis} of the $H\alpha$ line.

of the time variation of some parameters for the emission line $H\alpha$ and in 2018. From left to right, emission peaks blue and red peaks intensities (depths) R1 and R2 and accordingly its radial velocities RVp_1 and RVp_2, and in bottom relative intensities R1/R2 of emission peaks and whole bisector radial velocity RV_{bis} of the $H\alpha$ line. As can be seen from this diagrams, showed profile variations of the line simultaneously exhibit of the intensity and radial velocity variations of emission peaks, relation of peaks intensities R1/R2 and RV_{bis} parameters. Wave-like variation of the parameter RV_{bis} is occurred nearly for 112 days. This result on a smooth variation in the profiles and spectral parameters of the $H\alpha$ emission line confirms our first result and shows that the variability in the line possible is due to the inhomogeneity in the circumstellar disk.

The Hβ Line

In the line $H\beta$ we have observed mainly as a wide photospheric wings, on which at some nights are superimposed weak emission which causes wing asymmetry (Fig.3). From the fig.3 seen that, intensities of the emission components show variations from night to night.

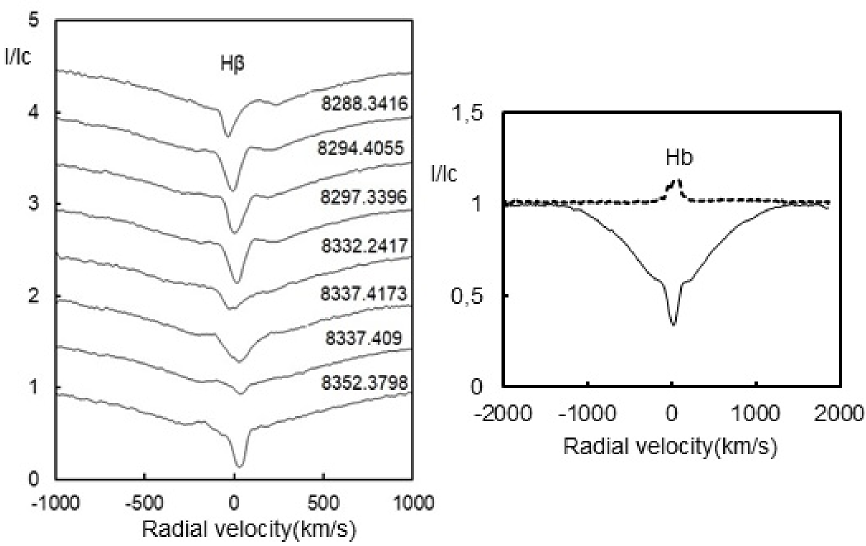

Fig. 3. The profiles of the line $H\beta$ (left panel) obtained in 2018. On the right panel average line profil (solid line) and its standard deviation (dashed line).

In the Fig.4 is presented the diagrams of time variations in the spectral parameters EW(equivalent width), FWHM (half-width), RVbis (radial velocity at half intensity) and peak. RVp – radial velocity of the deepest absorption component. As seen from the Fig.4, σ structure of the line (dashed lines) the peak of the line $H\beta$ exhibit similar variation with the line $H\alpha$.

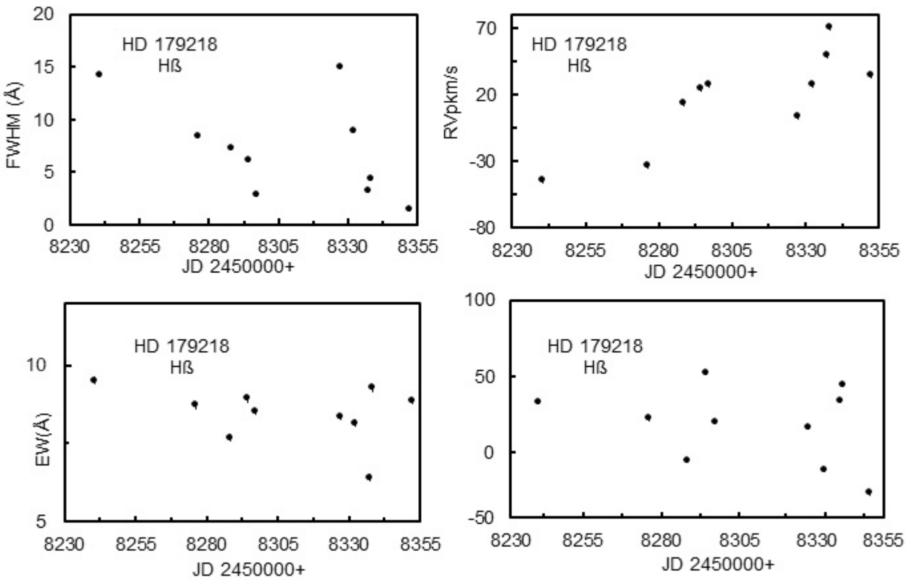

Fig. 4. The profiles of the line $H\beta$ (left panel) obtained in 2018. On the right panel average line profil (solid line) and its standard deviation (dashed line).

The $H\gamma$ Line

The $H\gamma$ line has a similar profile to the $H\beta$ line (Fig.5): the profile is purely absorption, and the weak emission component superimposed on the wings slightly distorts the symmetry of the wings.

In the Fig.6 is shown time variation of parameters of the $H\gamma$ lines. As seen from Fig.6, the spectral parameters EW(equivalent width), FWHM (half-width), RVbis (radial velocity at half intensity) and peak RVp – radial velocity of the deepest absorption component mainly not exhibit strong variations. Only the parameter FWHM is demonstrated some decreasing at JD 2458327, perhaps due to increasing emission component.

4. CONCLUSIONS

The 40-day cycle in the $H\alpha$ line was detected from richer spectral material, according to observations in 2015 (Ismailov et al. 2019). It was shown that the

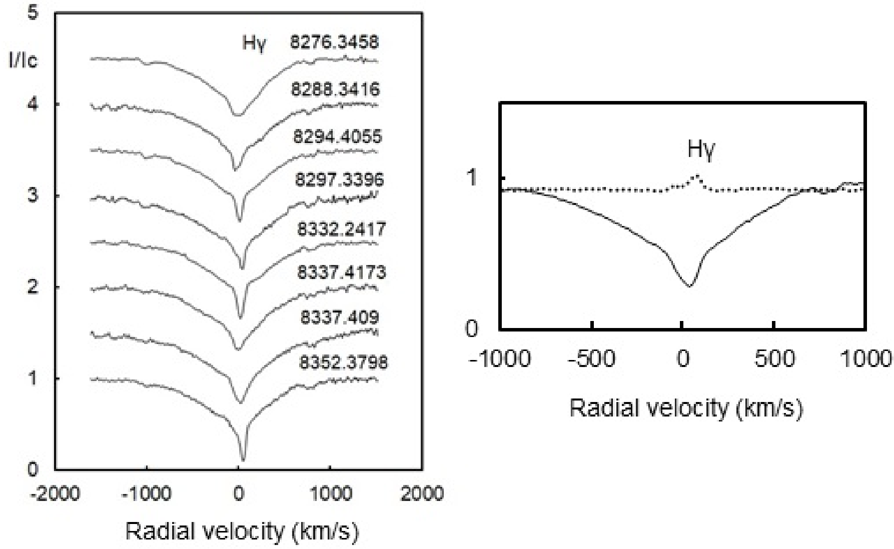

Fig. 5. Time variation of parameters of the absorption lines $H\beta$ for the data 2018.

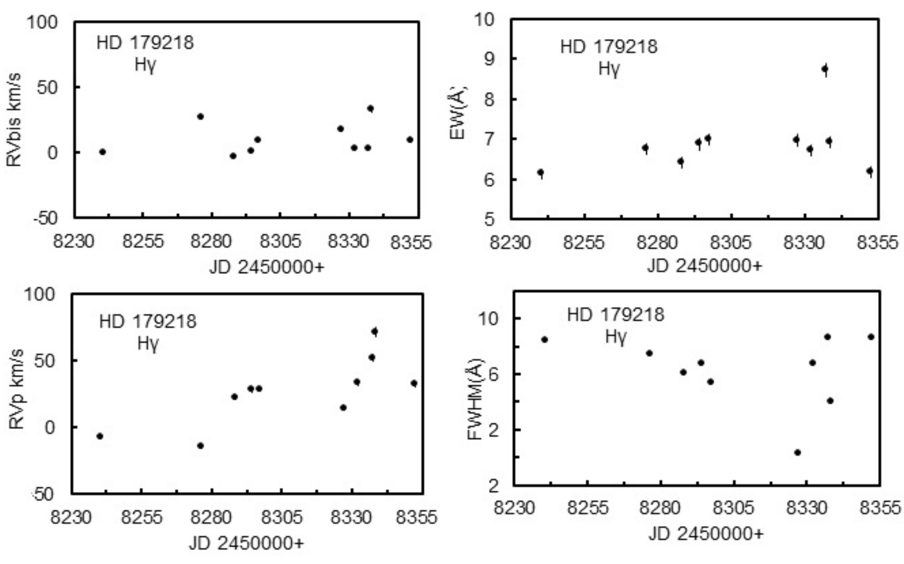

Fig. 6. The profiles of the line $H\gamma$ (left panel) obtained in 2018. On the right panel average line profil (solid line) and its standard deviation (dashed line).

equivalent widths and radial velocities of the emission component in the $H\alpha$ line demonstrated variation with a characteristic time of 40 days. During this cycle, the line profile changes simultaneously: an unusual variation in the profile of the $H\alpha$ near the minimum on the descending and ascending the leading branches of the first wave of changes in the spectral parameters. Despite the fact that the observational data in 2018 are small, the obtained variability in the $H\alpha$ line confirms our previous results. Here, the RV_{bis} parameter indicates a variations in a sinusoidal shape that lasts about 112 days. Perhaps the star exhibit a certain quasi-cyclic variability in the emission component.

Based on the results obtained in this paper, we can draw the following conclusions:

1. For the 2018 data the spectral parameters of the lines $H\alpha$ and $H\beta$ are demonstrated synchronous variation in the form of smooth wave for 112 day;

2. For 112-days we have observed two invers structure of the $H\alpha$ line profile. Intensities and radial velocities of Ib/Ir components is exhibited smooth variations.

3. We assume that the observed variability is due to rotational modulation, which is facilitate by asymmetry in the circumstellar disk. Such disk asymmetry in disk may be a result of presence another circumstellar bodies in keplerian orbit of the star.

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