SPECTRAL VARIABILITY OF THE LINE HeI 5876Ae/Be HERBIG TYPE STAR HD 179218

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The results of spectral observations of the Herbig Ae/Be type star HD 179218 are presented. Two wave-like cycles of variability in the parameters of hydrogen lines Hα and Hβ with a characteristic time of ~ 40 days are revealed. The first wave of variations is deeper; the branches of decreasing and increasing the spectral parameters of the lines are more clearly expressed. At the time of the first minimum, in the profile of the emission line Hα the appearance and disappearance of additional blue and red emission components are observed. At the same time, narrow absorption components were discovered in the Hβ line. Synchronously with this, a significant variation in the lines of He I, Si II, D NaI, [OI] was observed. In addition, the parameters of many spectral lines shows variations with smaller amplitude and with a characteristic time of 10-20 days. Possible mechanisms of the observed variability of the star are discussed.

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

The Herbig Ae/Be type stars (HAeBe) are pre-main sequence (PMS) objects of intermediate mass 2-10 M⊙ and are considered to be the progenitors of Vega type stars, which are surrounded with a residual protoplanetary disk. Spectral monitoring of individual objects has shown that in the spectra of these stars are observed variable emission and absorption lines (see, for example, Praderie et al. (1986), Pogodin (1994), Rodgers et al. (2002), Mora et al., (2004)). The same features are also characteristic of classical T Tauri stars (CTTS) (see, for example, Johns &Basri (1995), Schisano et al. (2009) and references therein). It is known that in young stars, emission lines, as well as some absorption lines, are formed in the circumstellar disks or in the envelopes of the stars. Such circumstellar matter can often participate in accretion, polar outflows, winds and other forms of disk interaction with the central star. Tracking the variation in the observed spectral lines makes it possible to perform diagnostics of the physical processes that are occurring in the stellar atmosphere and in the circumstellar environment. In young stars, in particularly, these processes can directly affect the formation of the planets and their evolution. Consequently, one of the important problems in the study of the early stage of evolution of stars is the study of the characteristics of the circumstellar structure and the processes of interaction of the central star with the surrounding matter.

HD 179218 (MWC 614, Sp B9-A2) is an isolated HAe/Be type star. Despite the fact that the star is relatively bright comparatively to other HAe stars, it has been studied less. Only when the star was included in the catalog of The et al. (1994), it became the subject of active research. The circumstellar surroundings of the star were studied by IR photometry and speckle interferometry by Millan-Gabet et al. (2001), Prizkal et al. (1997), which did not reveal closely spaced components. Spectral studies of the star were performed by Miroshnichenko et al. (1998) and in more detail, Kozlova (2004), Kozlova and Alexeev (2017).

According to the classification of Meeus et al. (2001), 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 Mendigutıa et al. (2012) the profile of the line Hα is consisting of a stable single-peak structure. Perhaps the star has a close companion, about 2.5 arcsecapart (Wheelwright et al., 2010). Fedele et al. (2008) 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 Hubrig et al. (2009) where on the data 2008 they have got about 51 ± 30 G.

The purpose of this paper is to carry out monitoring of the spectral variability of the star on spectral lines obtained in the visual range of spectrum.

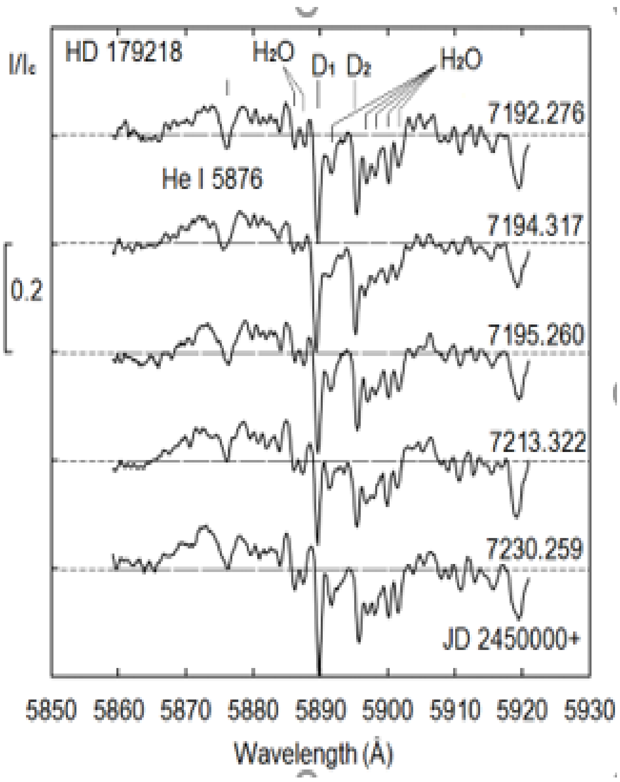

Fig.1. A spectral range of spectra is containing lines of HeI 5876 Å and doublet D1, D2 NaI. Individual sky (atmospheric) lines are indicated.

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In the Figure 1 have shown the spectral region containing the lines He I λ5876 Å and the sodium doublet D1, D2 NaI. This section presents the results of the analysis for the helium line. As can be seen, this line has blue and red emission components separated by a central absorption. This is the line in which only a saddle-like two peak emission profile is observed. The average half-width of the absorption is 1.5 Å with a scatter of up to 1.0 Å. The total width of the line at the continuum level is more than 20 Å. Figure 7 shows the profiles obtained at different nights, including at night JD 2457192 - 2457295, in which the first minimum of the spectral parameters of the hydrogen lines Hα and Hβ was obtained. As can be seen, the profile of the He I line λ5876 Å stably keeps the structure from night to night, does not show any noticeable variations.

The average value of the shift of the emission peaks in the He I line of 5876 Å corresponds to approximately -150 and +150 km/s, for the blue and red components, respectively. The radial velocities of individual emission peaks is showing a variability of about an average value 50 km/s. The central absorption is displaced about +20 km/s.

Figure 2 is presentded diagrams of variations in the equivalent widths of the central absorption of EWa, the radial velocities of the absorption vertex Vp, the ratio of the equivalent widths of the blue component to the red EW1/EW2, and the half-width of the FWHM absorption in the line HeI 5876. As can be seen, while parameters of the hydrogen lines are decreased, the parameters of the absorption component of the line HeI 5876 is showing a certain variation: EWa tends to increase, Vp is shifted to the red part of the spectrum by about 20 km/s, the ratio EW1/EW2 is increased by 5-7 times, and the parameter FWHM is also increased. A decrease in the FWHM of the absorption is observed between two waves of parameter reduction.

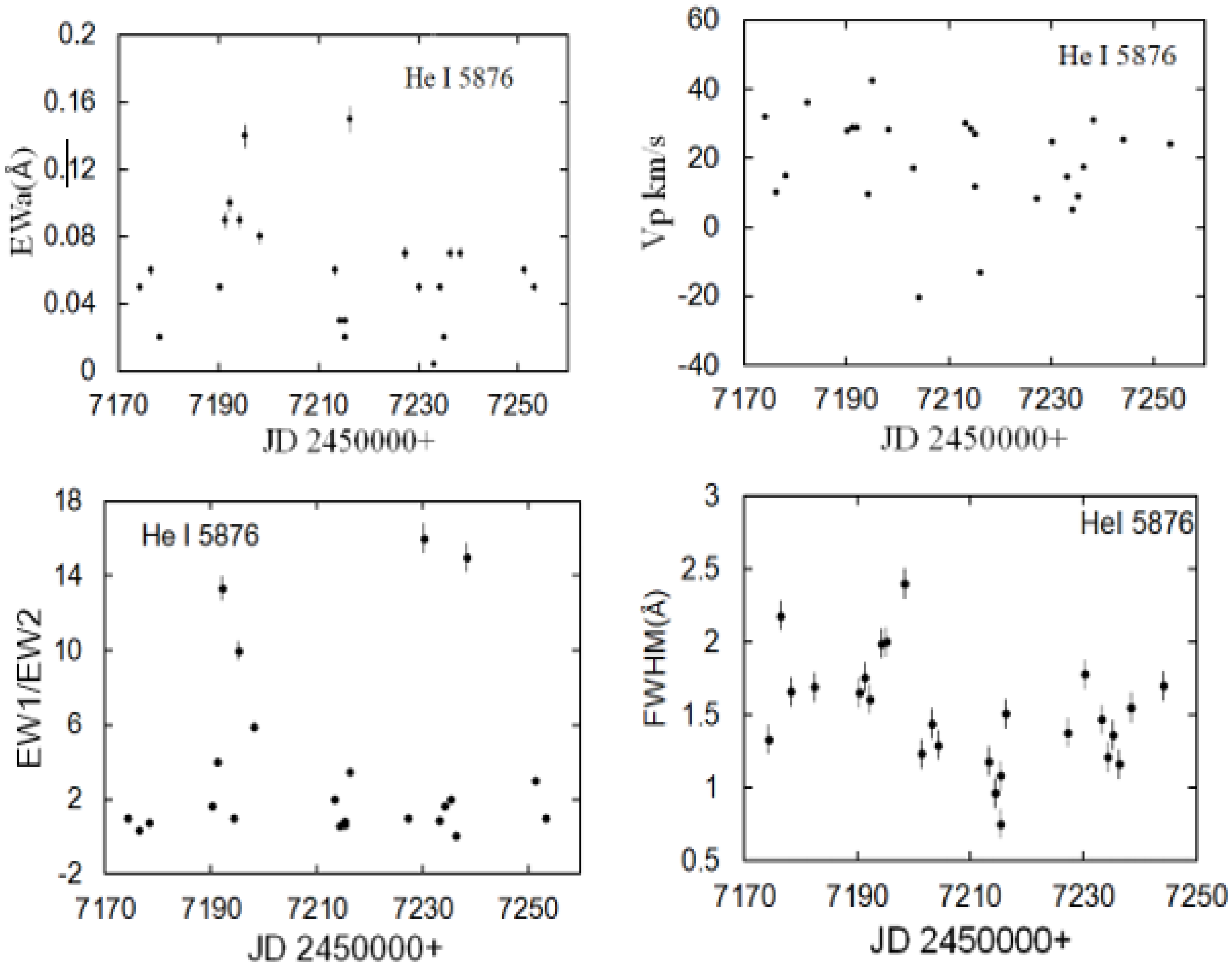

Fig.2. The time variation of the spectral parameters of the He I line is λ5876 Å.

In Fig. 2, the top panels are from left to right EWa-equivalent width of the absorption component, Vp is the radial velocity of the absorption peak, lower panels - EW1/EW2 are the ratio of the equivalent widths of the blue emission component to red and the FWHM of the absorption component.

It is also possible that a star can be a spectral-double or multiple system. In fact, it is difficult to explain the observed wave-like variation of the radial velocities and other parameters of the Hα line. Kozlova & Alekseev (2017) showed that the dependence of the brightness V on the color index V-I has two separate distributions. This fact is accepted by the authors in favor of the duality of a star.

The time of our observations from May to September 2015 corresponds to the minimum of the 4000-day cycle of variability found in Kozlova & Alekseev (2017). Therefore, the observed features of the variation in the spectrum of a star in the Hα line can be related to the moment of the star's stay at the minimum of the 4000-day cycle. Then the results obtained by us, perhaps, are a kind of unique event and can be observed only in the minima of the 4000-day cycle. Our observations have shown that in order to elucidate these questions it is necessary to perform a more dense series of photometric and spectral observations of the star.

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