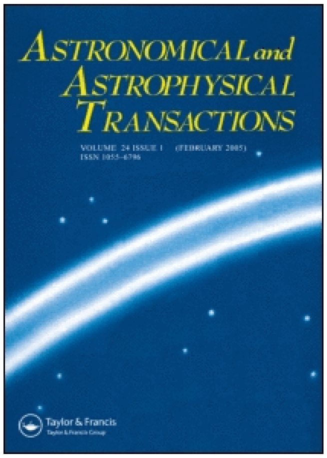

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Spectral variations of Ae-Be Herbig stars in the Mon R1 association

L. A. Pavlova [a]; L. N. Kondratyeva [a]; R. R. Valiullin [a]
[a] Observatory, Fesenkov Astrophysycal Institute, Almaty, Kazakhstan

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Spectral variations of Ae–Be Herbig stars in the Mon R1 association

L. A. PAVLOVA*, L. N. KONDRATYEVA and R. R. VALIULLIN

Observatory, Fesenkov Astrophysysical Institute, 050020 Almaty, Kazakhstan

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We present the change in the Hα emission-line profile of the spectra of some Ae–Be Herbig stars. In the spectrum of VY Mon, Hα may have one of three profile types: P Cyg, P Cyg III or single line in accordance with the brightness variations of the star. HD259431 now shows a double Hα profile with the red component stronger than the blue component, while in the earlier observations the blue peak was higher than the red peak. Finally, the last Hα profile of LkHα215 is very similar to that obtained by Finkenzeller *et al.*

Keywords: Ae–Be herbig stars; Spectral profiles of Hα

One of the major problems caused by the Ae–Be Herbig stars is their strong activity. There are emission lines of different ionized elements in the spectra of most of these stars. The study of emission-line profiles of Ae–Be Herbig stars is often used to investigate the physical conditions in the emitting regions. Hα emission remains one of the best probes of the inner circumstellar environments of young stars and contains information about the kinematics, excitation and geometry of the gas. The large infrared and submillimetre continuum excesses and sometimes veiled photospheric absorption are indicators of the presence of cool circumstellar material with a complicated structure [1]. The interpretation of observational data critically depends on whether the circumstellar matter is organized in a flat disc or in spherical envelopes [2–5]. The detailed modelling of emission-line profiles, mainly for the optically thick lines such as Hα, is very sensitive to the radiative transfer, level populations, density and velocity field. However, the evidence that Hα emission may be the result of the combined contributions of more than one region is very important The envelope structure can be complicated by the presence of the magnetic fields both of a star and of the circumstellar environment and can be changed with time by different parameters on the line of sight. The analysis of the dusty environment is used to develop an empirical model of the formation and evolution of pre-main sequence stars. The main sources of variability are unknown, and it is difficult to separate the influences of stellar activity and circumstellar matter effects. More complete understanding of the variety of line-forming regions requires the study of the profiles of many lines of different

*Corresponding author. Email: anatol@aphi.kz

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elements. Only a long-term set of observations for very many Ae–Be Herbig stars can help us to understand this phenomenon.

The emission profiles of Hα can be classified as double peaked, single or P Cygni. They show variability from a few hours up to a year. Some stars are known to change the Hα profile from one type to another, but the moment of such an event is unpredictable [6–8]. The highly variable component of the Hα line profile affects mainly the blue region and the central region of the profile, and the time variable must be connected with the change in the conditions in the envelopes or with a mechanism of variability such as a rotating star or envelope, mass loss, infall or pulsation [4, 9]. The long-term study of the variations in the emission profiles can provide a definition of the natures of the stars.

Our main goal is to search for the characteristic timescales and amplitudes of the variability of emission-line details in order to study the arrangement of emission regions and the basic mechanisms of variations. We give now the results of spectral observations on three stars in the Mon R1 association: VY Mon, LkHα215 and HD 259431. Observations were carried out with the 70 cm telescope of the Astrophysysical Institute (Almaty, Kazakhstan) over 20 years. The apparatus and the method of processing the observations have been described in [10, 15].

VY Mon is one of the youngest stars, with a large reddening (A_V of magnitude not less than 7.0), with a very high degree of polarization (about 10%) [11] and with visual and infrared excesses. Its spectral class was identified with large uncertainty: O9–F5 [2, 3, 5]. Our observation programme began in 1986; the first spectrograms with a resolution of 2.7 Å showed an Hα emission line with a P Cyg peculiarity. In 1988 and 1991 a change in profile type was displayed, from P Cyg to P Cyg III (because an additional blue emission line had appeared instead of P Cyg absorption), and then another change, to a single-emission-line profile, was recorded [12]. When VY Mon is seen as a bright star, the P Cyg peculiarity is observed and, when the star becomes weaker, the profile turns into P Cyg III and then into a single-line profile. The light curve of VY Mon presented in [13] is quite similar to those of Herbig Ae–Be stars of Algol type. However, VY Mon shows a strong variation in colour index without significant changes in brightness. The velocity value of P Cyg absorption varies from −62 to $-340\,\mathrm{km\,s^{-1}}$; the initial increase is replaced by a decrease over 8 months. We have derived the systematic values of the shift of the main emission centre for different types of profile: $-62\,\mathrm{km\,s^{-1}}$ for P Cyg, $-120\,\mathrm{km\,s^{-1}}$ for P Cyg III, and $-140\,\mathrm{km\,s^{-1}}$ (for the single line). However, the variations in the intensity of the main emission relative to the continuum and to the red edge of the line are weak (figure 1). This can be connected with the variation in optical thickness without morphology changes. All three types of profile imply that high-velocity outflows can be important envelope components and can be explained by the same limited models of anisotropic stellar wind, with a variable terminal velocity.

LkHα215 is a star of spectral type B1–B7e with a very broad double emission line Hα. The emission lines Ca II K, Ca II (8542 and 8498 Å) and O I (8446 Å) have identical types of profile [14]. In [6] for the separate components of the Hα profile the following values of radial velocity were obtained: −550, −120, −35, +105 and $+450\,\mathrm{km\,s^{-1}}$ for the blue edge, peak, central absorption, peak and red edge respectively. Our estimations are somewhat different: −575, −32, +58, +141 and $+510\,\mathrm{km\,s^{-1}}$, respectively (figure 2). In the case of the double-peaked lines the relative intensities of the red and blue peaks change considerable and alternately reach the maximal intensity. Such mechanisms as outflow (blue peak less) or infall (red peak less) of envelope matter may be suggested as the interpretations of these changes. The central absorption varies near zero point with a small amplitude. This could be connected with the variable thickness of matter on the line of sight. It is known that the large majority of Herbig Ae–Be stars show deep central absorptions, and this fact demonstrates that equatorial circles of obscuring material can be thick and close to the line of sight.

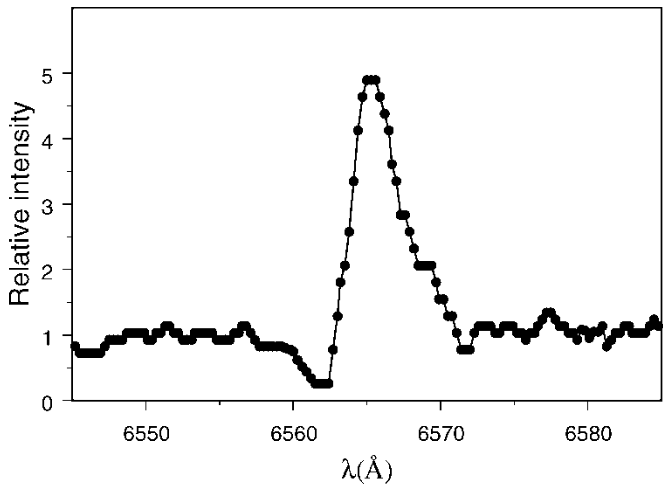

Figure 1. The Hα profile in the spectrum of VY Mon.

HD 259431 is a star of spectral type B6pe–AOe [2, 5, 9, 14] with the broad double emission lines of Hα , Hβ , Hγ and so on. The early observations showed only Hα with a strengthened blue peak unlike our 2005 data which presented the opposite picture; however, the radial velocity parameters of the profile are the same. The emission lines Ca II K (3933 Å), Ca II (8542 and 8498 Å), O I (8446 Å) [14] and Mg I (2790 Å) have double-peaked profiles. The identical types of line profile of different elements may prove that all of them are formed in the same region, near the star, inside an asymmetric disc-like envelope. Usually, the N I (8629 Å) line is detected in the hotter B stars, because of its high ionization (14.5 eV) and excitation (10 eV) energy. The correlation between He I (4471 Å) and Mg II (4481 Å) confirms the B6e spectral class as favourable. The spectral variations are very irregular (figure 3). A short time variability is related to a region closer to the star and reflects a change in the velocity field. Some stars are known to change Hα profiles from one type to another, but this fact is

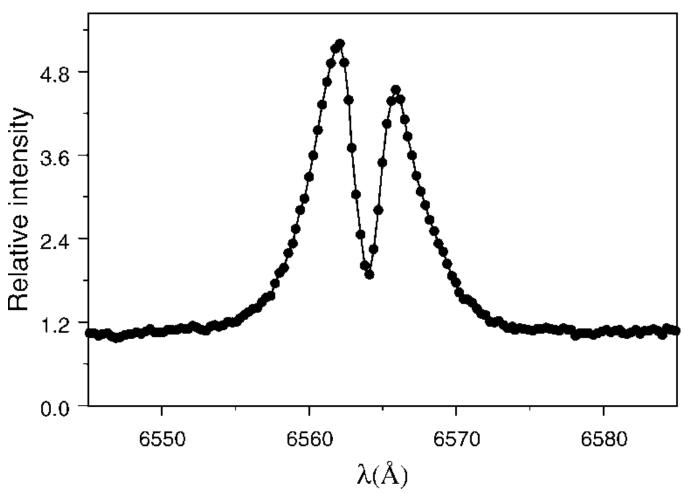

Figure 2. The Hα profile in the spectrum of LkHα215.

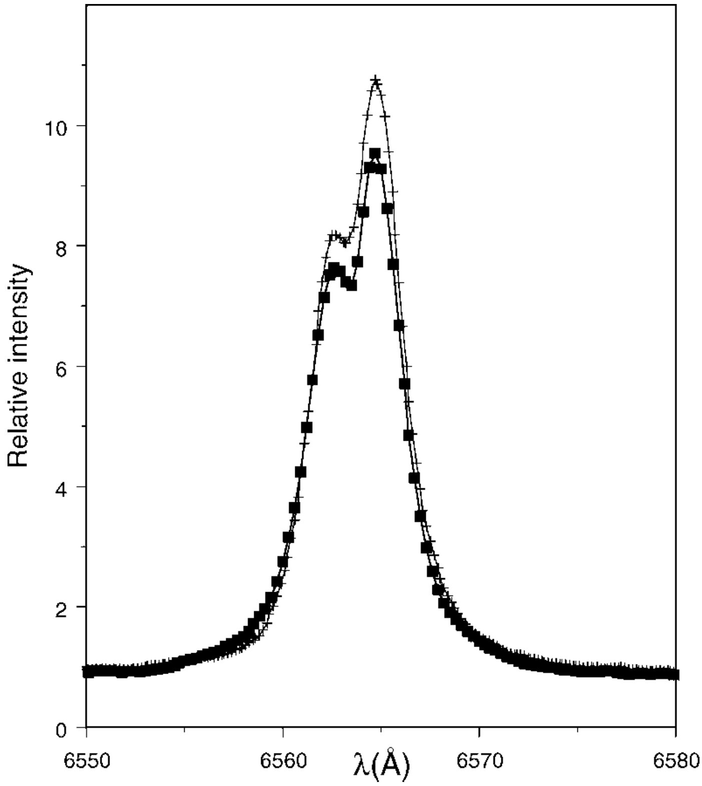

Figure 3. The Hα profile in the spectrum of HD 259431. Data for 15.03.2005-boxes, these for 21.03.2005-crosses.

not connected with their masses or evolution status [6, 9, 15]. All three stars can have disc-like envelopes; however, the types of profile are different and do not depend on extinction or spectral class but do depend on the thickness of the toroidal envelope and its inclination to the line of sight.

References

[1] Th. Henning, A. Burkert, R. Launhardt, Ch. Leinert and B. Stecklum, Astron. Astrophys. **336** 565 (1998).
[2] M. Cohen and L.V. Kuhi, Astrophys. J., Suppl. Ser. **41** 743 (1979).
[3] S.C. Casey and D.A. Harper, Astrophys. J. **362** 663 (1990).
[4] J.-C. Bouret and C. Catala, Astron. Astrophys. **340** 163 (1998).
[5] J. Hernandez, N. Calvet, C. Briceno, L. Hartmann and P. Berlind, Astron. J. **127** 1682 (2004).
[6] U. Finkenzeller and R. Mundt, Astron. Astrophys., Suppl. Ser. **55** 109 (1984).
[7] M. Fernandes, E. Ortiz, C. Eiroa and L.F. Mizanda, Astron. Astrophys., Suppl. Ser. **114** 439 (1995).
[8] Bo. Reipurt, A. Perdosa and M.T.V.T. Lago, Astron. Astrophys., Suppl. Ser. **120** 226 (1996).
[9] U. Finkenzeller and I. Jankovics, Astron. Astrophys., Suppl. Ser. **57** 285 (1984).
[10] L.N. Kondratyeva, Astron. Astrophys. Trans. **22** 181 (2003).
[11] L.A. Pavlova and F.K. Rspaev, Astrofizika **23** 521 (1985).
[12] L.A. Pavlova, Astron. Zh. **72** 539 (1995).
[13] A.S. Miroshnichenko, R.V. Yudin and S.D. Yakubov, Astron. Astrophys. Trans. **1** 211 (1992).
[14] F. Hamann and S.E. Persson, Astrophys. J., Suppl. Ser. **82** 285 (1992).
[15] R.V. Yudin, Astron. Astrophys., Suppl. Ser. **144** 285 (2000).