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Spectral variability of emission lines in young stars

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The structure of emission lines Hα and Hβ in the spectra of three young stars was investigated. The gradient of line center velocity from the basis to the top of line was found in DI Cep, AB Aur and MWC 361.

Keywords: Young stars; Spectral variability; Emission line profiles

One of the important questions in research of young stars is to study the structure and physical properties of circumstellar disks. Studying of the dynamics and physical condition of environments would allow us to determine energy sources in abnormally high temperatures, geometry of the disk as a whole and its interaction with the central source and circumstellar environment.

The aim of the present study is, based on spectral observations, to investigate quick-time and long-time variations in the spectra of different types of young stars which possess strong emission spectrum. In particular, the study of hydrogen emission lines would reveal the features in the structure of circumstellar environments.

Spectral observations have been carried out in kassegrain and coude focuses of 2 m telescope of ShAO, using CCD 530×580 px. The spectral resolution at the line Hα is 14000 and 30000, accordingly, an average signal to noise ratio is 60. The spectral range covered $\lambda\lambda$ 4700–6700 Å. Observations were carried out during the summer and autumn periods of 1998-2006. Processing of spectral material has been executed with program DECH developed in SAO of the Russian Academy of Sciences. By results of processing spectra of standard stars at ratio S/N about 100, deviation of measurement of equivalent width has made ±0.02 Å, and the maximal deviation on intensity has made 0.5%. In measurements of radial velocity the deviation is not more than ±2 km/s.

Structures of lines Hα and Hβ basically have two intensive peaks with a failure in the center. Each of these peaks in turn shows the complex structure consisting of 3–4 components, allocated as separate peaks. In separate nights also the small emission peaks displacement both in blue, and in the red part of the spectrum, approximately ±400 km/s was discovered.

The analysis of structure of lines Hα and Hβ in all young stars has shown that these lines have rather complex multicomponental structure. It is interesting that all observable components moved apart from each other on characteristic displacement

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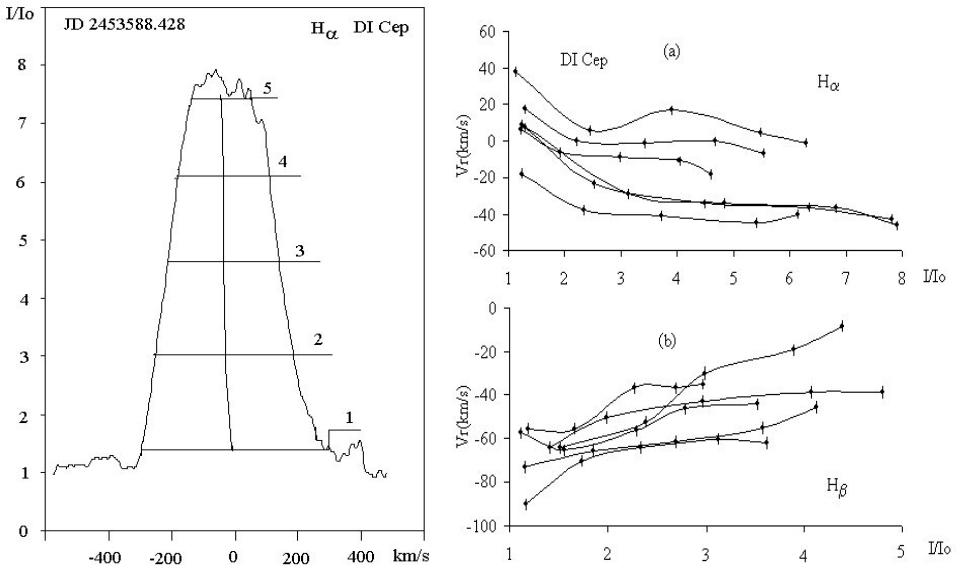


Figure 1 On the left part of figure typical structure emission of the Hα of DI Cep and levels on which measurement of displacement of the center of the line at this level relative to wings has been presented. Figures at different levels show numbers of measured points. On the right part of Fig. 1 a displacement of the center of lines Hα and Hβ at different levels versus of relative intensity is shown. Continuous curves are related to the data of one line of profile. Vertical hyphens are a level of the deviation of measurements in displacement.

about 30±5 km/s. In each line Hα and Hβ rather stable 3–4 components are observed. If each peak in emission is taken as a separate clot of gas, their observable velocities of movement can be attributed to existence of stratification of gas on equal distances from the central star. It can be real when the disk of the star has spherical structure with intervals between rings.

For the analysis of structure of the line displacements in the central part relative to wings at five different levels of intensity for each line of hydrogen has been measured. The first readout – shift of the center of the line relative to wings at the level of the continuum, fifth – shift of the center of the line at the top level. Points 2–4 are distributed in regular intervals on depth between points 1 and 5.

On the left panel of Fig. 1 a real structure of the Hα line of DI Cep and the method of calculation of shifts of the center of line relative to wings at different levels of intensity schematically is shown. It is shown that emission lines Hα and Hβ in star DI Cep have an asymmetric structure: the central part of the line at the top level has significant shift (-60, -80 km/s) in comparison with the level of the continuum. Variation of displacement of the center of Hβ varies linearly, and at line Hα in a more complex form.

The similar gradient of velocity of the line center from the basis to top for Ae/Be Herbig AB Aur and MWC361 stars was observed (Fig. 2). Such features of structures testify that, apparently, radiating gas in an environment is optically transparent for the bottom radiating layers of the envelope.

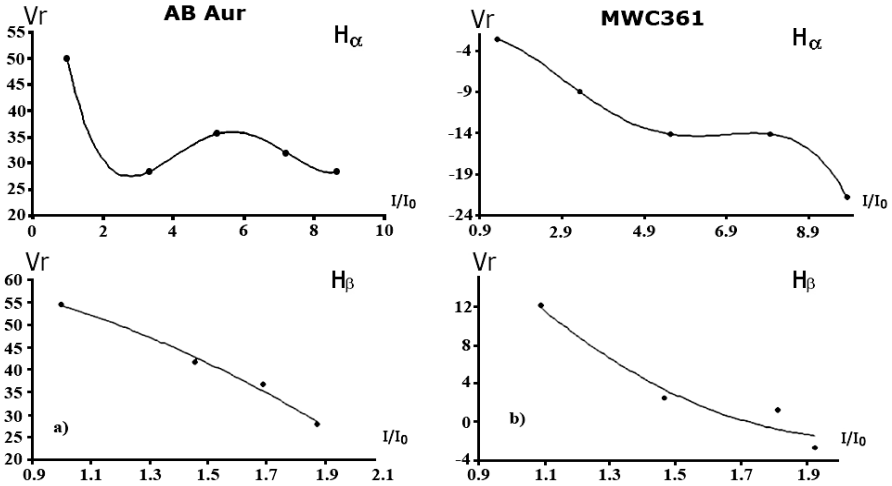


Figure 2 The same as on Fig. 1, for Ae/Be Herbig type stars AB Aur and MWC361.

The light variation of DI Cep in an optical range shows a high degree of correlation with equivalent width of emission lines of hydrogen.

During 1–2.5 hours of observations, no significant quick variations in structures and spectral parameters of separate components of Hα line of MWC361 have been revealed.