ULTRAVIOLET SPECTRUM VARIABILITY OF BP TAU

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ABSTRACT. Results of the ultraviolet IUE archive spectrum researches of classic T Tauri type star BP Tau had been presented. Spectroscopic parameters of mainly strong emission lines were measured. On the more full massive which had been created on the intensity values of the emission doublet Mg II λ2800 Å a variability with period $P = 8.275 \pm 0.005$ days with high confidence level was obtained. There is some group of lines, intensities of emission lines for which were showed decreasing for more than 13 years of time interval. As a rule, lines with high potential of excitation related to the first group. More probable, such lines shows periodic variability. It is showed that we have as a minimum two local physical conditions of matter in the circumstellar disk of the star.

Key words: Pre-Main Sequence Stars: UV spectrum: variability; individual: BP Tau.

1. Introduction

Studying of the UV spectra of classical T Tauri stars (TTS) represents significant interest for understanding the physical nature of young stars. Mainly it is connected with following factors: for TTS in this wavelength range of spectrum the excess of radiation in a continuum is observed; besides emission lines of extremely high temperature excitation (He II, C IV, Si IV, O I, etc.) are observed. Researches of these features of the individual TTS can be a key to understanding of mechanisms of activity of young stars.

BP Tau is one of classical Tauri type stars (CTTS) with spectral class K7V (Herbig, Bell, 1988). According to photometric $UBVRI$ data's a radiation of the star can be explained with a hot spot model with temperature $8200°K$, covering 0.36% of a surface of the star (Vrba et al., 1986). Simon et al. (1990) showed that a variation in the UV continuum radiation and magnitudes of the star in $UBVRI$ bands shows some correlation. 14-day's monitoring executed by Gomez de Castro and Franqueira (1997) has shown that intensities of spectral lines O I, Si II, Mg II and UV light radiation in the band λ2900 Å have varied synchronously. On the received from the Hubble Space Telescope archive structures of resonant lines Mg II λ2800Å was investigated. In this work is showed that an absorption component was displaced in a red part of the spectrum.

On the analysis data optical light of BP Tau periods of variability 6.1, 7.6, and 8.3 days Simon et al.(1990), Gomez de Castro and Franqueira (1997) and Gullbring et al (1996) had been obtained. Values of these periods founded by different authors were not coordinated among themselves. Those are inconsistent results in interpretation of the activity mechanism and nature of the emission spectrum of the star. For detailed research and the statistical analysis of physical characteristics of CTTS it is necessary to receive a plenty a homogeneous spectral material. From this point of view final archive IUE is a unique source for research of such objects (Valenty et al. 2000, Johns-Crull et al. 2000, Valenty et al. 2003). The objectives of the present work are researches of UV spectrum of BP Tau on the spectral material, obtained from the IUE archive data.

2. Observations and results

The UV spectrum of the star has been investigated on the spectrograms taken from IUE archive data. It has been used only 15 SWP and 62 LWP type spectrograms. Spectral resolution is at 6 Å. For avoiding the account of interstellar reddening in spectral lines, and also additional mistakes because of heterogeneity of the received spectrograms we applied a classical method of processing of spectrograms in which measurement is made in relative units: after carrying out of a level of the spectral continuum the central depths (residual - intensity) $R_\lambda = 1 - I/I_0$ and half widths ($\Delta\lambda_{1/2}$ - FWHM) of lines were determined. Where, I - an absolute intensity at top of the line, I_0 - an absolute intensity of line at the level of continuum. In such measurements the mainly error in intensity of the line arises because of wrong carrying out of a level of the spectral continuum. Therefore, we carried out pro-

cedure of setting of the spectral continuum level very carefully,achieving a constancy of carrying out of a continuum through stable points of the spectrum. Mean deviations are in intensity measurements at 5 %, and in half widths at 15-20 %.

For measured spectral parameters variations from day to day and during 5-6 years characteristic time have discovered. For example in Fig.1 time variability diagrams for parameters R_λ and $\Delta\lambda_{1/2}$ have presented. Full time of observation is equal nearly 13 years $(1979-1992)$.

The most continuous daily long IUE observations on the star have been carried out in two series: 1) JD $2446705-2446730$, duration about 25 days and 2) JD $2448627-2448641$, duration about 14 days. Most numerous measurements in this interval have been carried out for a doublet Mg II $\lambda\lambda 2795, 2802$ ÅÅ, (further, Mg II $\lambda 2800$ Å) which in spectrograms are observed as one composed emission. These data allow to search of cyclic changes in the spectral parameters in an interval about $6-8$ day.

In the Fig. 2a and 2b we show a time variability of intensity R_λ for doublet Mg II $\lambda 2800$ Å for the abovementioned two different time intervals. As it is visible from Fig.2, a change of the line intensity has a cyclic character with characteristic time $7-8$ days.

We have analyzed time dependence for intensities of different emission spectral lines. We have found that on the character of time variability, lines are divided to 2 groups: 1) group of lines, which show monotonous decreasing during all IUE observation (for more than 10 years), 2) lines which do not show the some certain law in change of the parameter R_λ.

In fig.3 for example we presented time variability of the R_λ and FWHM for spectral lines SiIV $\lambda 1403$ Å, [Si III] $\lambda 1893$ Å which concern to first of the named groups of emission lines. Apparently, FWHM of lines have not shown the certain dependence on time for these lines. It testifies that besides quick changes, there is also a long-time variability in emission spectrum of BP Tau.

For lines Mg II $\lambda 2800$ Å nightly parameters R_λ were used for the period search, resulting in a set containing 62 points spread over 13 year interval of the observation. We use the Scargle (1982) periodogram method as recommended by Horne and Balinas (1986) to search for periods. The greatest peak in a power spectrum is observed at frequency $\nu = 0.1208 \pm 0.0005\mathrm{d}^{-1}$, that corresponds to the period 8.275 ± 0.005 day. The validity level of this peak is over 90 %.

In Fig.4 phase diagrams for period 8.275 days for lines Mg II $\lambda 2800$ Å and SiIV $\lambda 1403$ Å lines have presented. There is certain group of lines for which a periodicity does not obtain.

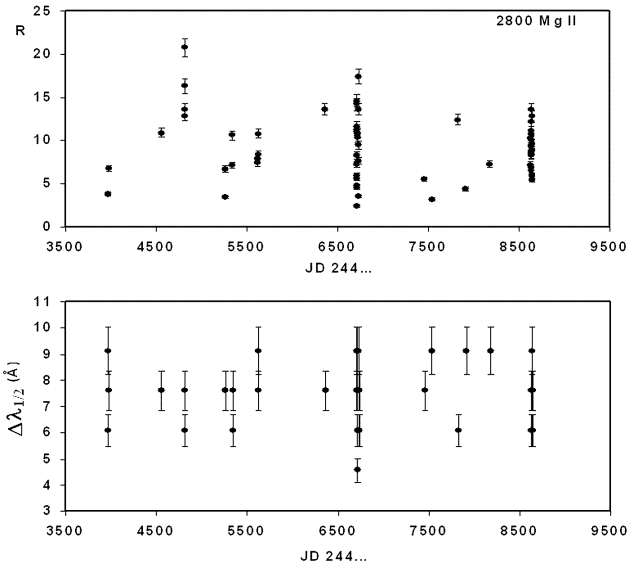

Figure 1: Time variability diagram for parameters R_λ and $\Delta\lambda_{1/2}$ for 13 years $(1979-1992)$.

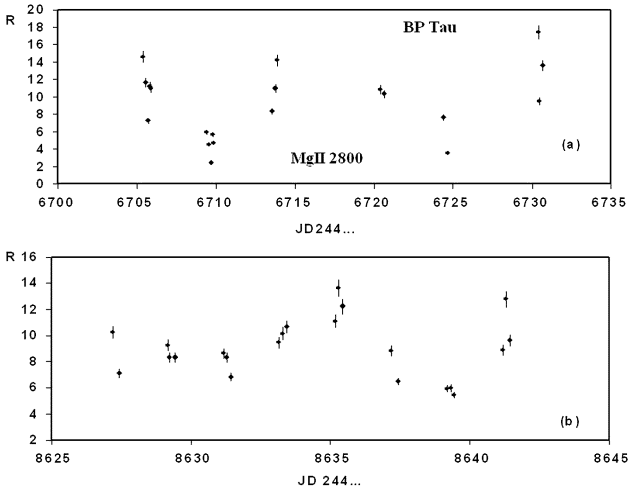

Figure 2: a and b. From day - to day time variability diagrams for intensities of doublet Mg II $\lambda 2800$ Å for two separate data.

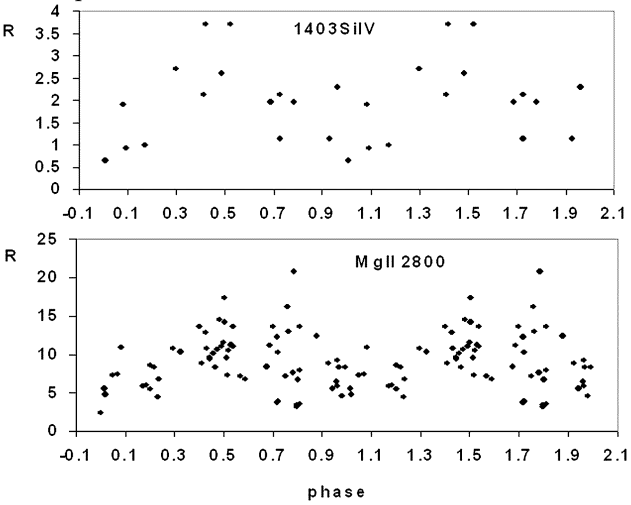

Figure 4: Phase diagrams for period 8.275 days for lines Si IV $\lambda 1403$ Å and Mg II $\lambda 2800$ Å.

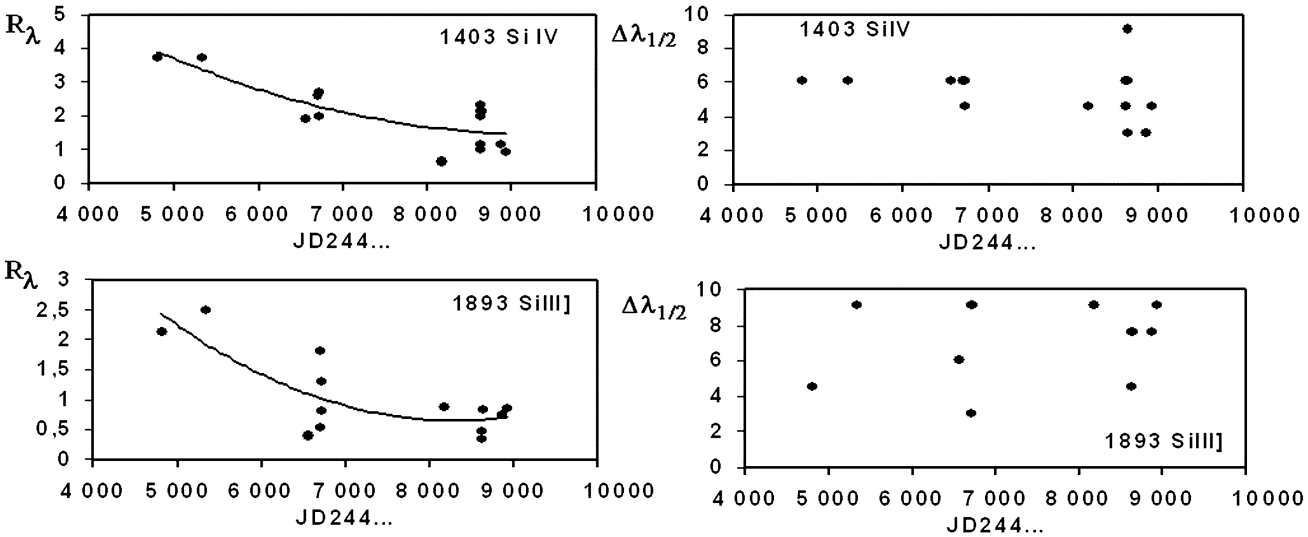

Figure 3: Time variability of the parameters R_λ and $\Delta\lambda_{1/2}$ for emission lines Si IV λ1403 Å and [Si III] λ1893 Å.

3. Conclusions.

1. Intensities of emission lines showed variability from day-to day and some group of lines showed large time scale variability with characteristic time 5-6 years.
2. Variability of the central depths R_λ for Mg II λ2800 Å and some other spectral lines with probable period = 8.275 days had been discovered. It is very close value with photometric period 8.3 day obtained by Richter et al. (1992). There is certain group of lines for which a periodicity does not obtained.
3. For time interval of 13 years a character of variability of emission lines are divided into two groups: a) Intensities of lines for this time was monotonous decreased, b) Intensities of lines show irregular variability.
4. As a rule, lines with high potential of excitation related to the first group. More probable, such lines shows periodic variability. It is showed that we have as a minimum two local physical conditions of matter in the circumstellar disk of the star.

References

Gomez de Castro A.I., Franqueira M.: 1997, *ApJ,* **482**, 465.
Gullbring E., Barwig H., Chen P.S., Gahm G. F., Bao M. X.: 1996, *AsAp,* **307**, 791.
Herbig G.H., Bell K.R.: 1988, *Lick Obs. Bull.,* **1111**, 90.
Horne J.H., Balinas S.L.: 1986, *ApJ,* **302**, 757.
Johns-Krull C.M., Valenti J.A., Linsky J.I.: 2000, *ApJ,* **539**, 815.
Richter M., Basri G., Perlmutter S., Pennypacker C.: 1992, *PASP,* **104**, 1144.
Scargle J.D.: 1982, *ApJ,* **263**, 835.
Simon T., Vrba F.J., Herbst W.: 1990, *AJ* **100**, 1957.
Valenti J.A., Fallon A.A., Johns-Krull C.M.: 2003, *ApJSS,* **147**, 305.
Valenti J.A., Johns-Krull C.M., Linsky J.I.: 2000, *ApJSS,* **129**, 399.
Vrba F.J., Rydgren A.E., Chugainov P.F., Shakovskaya N.I., Zak D.S.: 1986, *ApJ,* **306**, 199.