Orbital Parameters and Variability of the Emission Spectrum Massive Double System 105 Tau

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Using high resolution spectroscopy, we detected the weak lines of the secondary component in the known massive binary system 105 Tau. Orbital parameters of the system are derived. Observations show that both components are MS stars with the more evolved primary star. The orbital variability of the weak emission component in the profile of Hα line is found. Accretion disk is formed around the less massive secondary component.

Some massive double systems with the Main Sequence (MS) components demonstrate, as a rule, the presence of a weak emission component in the core of the Hα line. One of such systems is the well known single-lined binary system 103 Tau (HR 1659, HD 32990, Sp B3V, V = 5.3^m). The system was discovered as a single-lined spectroscopic binary in 1924 [1]. Its period ($P_{orb} = 58.25^d$) and orbital elements were found in [2] and corrected in [3]. The star has a weak emission component in the core of the Hα line [4].

For understanding nature of emission in the Hα line and obtaining an improved orbital solution of the system, we carried out high resolution spectroscopy of 103 Tau in the region of lines HeI λ 6678 Å and Hα in the coude focus of 2.6 m telescope of CrAO with the spectral resolution 30000 in 2001–2004.

In Fig. 1a we present two typical spectra in the region of the HeI λ 6678 Å line. As it is seen from the figure, we found a faint secondary component in orbital elongations and its intensity allows us to construct the orbit of the secondary and obtain the complete spectroscopic orbital solution of the system. Using the code FOTEL [5], we obtained an improved orbital solution with $P_{orb} = 58.305(3)$, $e = 0.277(27)$, $K_{prim} = 44.8(2.8)\,\mathrm{km\,s^{-1}}$, $K_{sec} = 79.3(8.7)\,\mathrm{km\,s^{-1}}$, $\gamma = 14.6(1.0)$, $M_{prim}\sin^3 i = 6.6\,M_\odot$, $M_{sec}\sin^3 i = 3.7\,M_\odot$, $a\sin i = 50\,R_\odot$ and $b\sin i = 88\,R_\odot$. Variability of the radial velocities with the phase of the orbital period and the orbital solution obtained are presented in Fig. 1b.

The rotational velocities of both components of the system are synchronized in periastron. For the primary component, $v\sin i = 47 \pm 11\,\mathrm{km\,s^{-1}}$ [6] is identical to $K_{prim} = 45.7 \pm 2.1\,\mathrm{km\,s^{-1}}$. Our estimates of the rotational velocity of the secondary have lower quality because of low intensity of the line, but it is less than 80 $\mathrm{km\,s^{-1}}$ and is close to the orbital value $K_{sec} = 78.9 \pm 6.2\,\mathrm{km\,s^{-1}}$.

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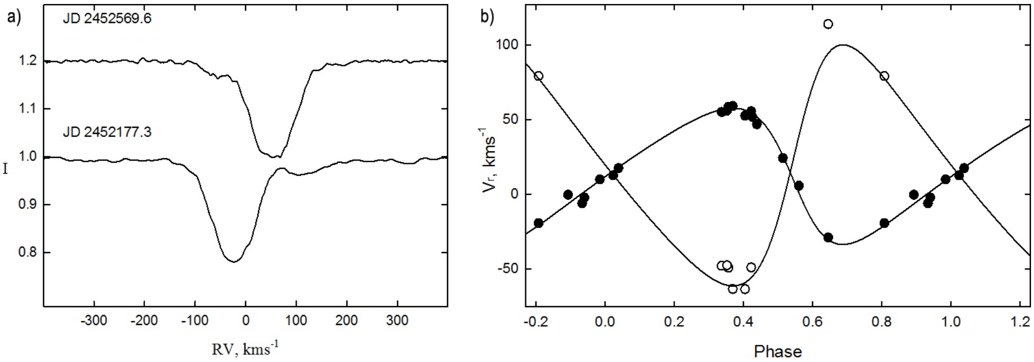

Figure 1: a) Spectral region around the HeI $\lambda\,6678$ Å line. b) Radial velocity changes with the phase of the orbital period. Dots show the radial velocities of the primary component, open circles do the radial velocities of the secondary component.

Our analysis of the orbital variability of the faint emission component in the core of Hα line allows us to locate it in the Roche lobe of the secondary, which most probably is a late B star on MS. The primary, more massive component, is a MS or normal giant star that definitely has not reached its Roche lobe and cannot be an active mass loser. For the secondary, synchronization of the rotational and orbital velocities in periastron means that the accretion disc has appeared, which says about sporadic mass loss by the primary or recently started mass exchange.

References

1. *S.N. Adams, A.H. Joy, R.F. Sanford*, Publ. Astron. Soc. Pacific, **36**, 137, 1924.
2. *S.N. Hill*, Publ. Domin. Astrophys. Obs., **4**, 261, 1929.
3. *H.A. Abt, A.E. Gomez, S.G. Levy*, Astrophys. J. Supll., **74**, 551, 1990.
4. *J. Boulon, V. Doazan, N. Letourneur*, Astron. Astrophys., **40**, 203, 1975.
5. *P. Hadrava*, Prep. Astron. Inst. Czech. Acad. Sci., 1, 1991.
6. *W. Huang, D.R. Gies, M.V. McSwain*, Astrophys. J., **722**, 605, 2010.