Publ. Obs. Astron. Belgrade No. 44 (1993), 107–110

MASS TRANSFER IN INTERACTING BINARY W SER-TYPE SYSTEMS

Karetnikov, V.G., Menchenkova, E.V., Nazarenko, V.V.

Astronomical Observatory of the Odessa State University
Ukraine, 270014 Odessa, T.G.Shevchenko Park
root%astro.odessa.ua at relay.USSR.EU.net (Internet)

By the method, proposed by Nazarenko V.V.(1993) and using the observational data, obtained by different authors, the physical conditions in the stream in the neighbourhood of the point L1 were calculated for three interacting binary systems of W Ser-type: β Lyr, V367 Cyg, RY Sct. Nazarenko V.V.(1993) showed, that the properties and dynamic of the stream in the neighbourhood of the point L1 can be calculated only on the basis of the parameters of the system and of the conditions in the atmosphere of the Roche lobe filling component, without using any additional assumptions.

Our calculation showed, that in the investigated systems saturation in the vicinity of the point L1 takes place. That means, that a further increase of the radius of the mass losing companion does not lead to a considerable increase of concentration of matter in the point L1. The process of reaching the saturated state of the mass losing component is good illustrated by Fig.1.

By changing the value Xo (Xo is the position of the deepest layer in the model atmosphere by Kuruch R.L. (1979) on the X-axis) we calculated several versions of the stream parameters near the point L1 for several observational data obtained by different authors. The results of our calculations are collected in Table 1. XL is the position of the point L1 on the X-axis, NL is the concentration of matter in the point L1, TL is the temperature in the point L1, VL is the X-component of the stream velosity and VL(s) is the sound velosity in the point L1. Rs is the stream radius, R is the Roche lobe of the mass losing star, $\dot{M}$ is the rate of mass transfer through the point L1. All dimensions are given in units of the distance between the components of the binary system, velosity are given in km/s.

The analysis of the obtained results shows that in the result of the evolutional expansion of the mass losing component the deep layers of its atmosphere reach the neighbourhood of the first Lagrangian point L1 and a stream of axial symmetric shape is formed. Its radius is comparable to the dimension of mass losing component (They are only two times less than the radii of the mass losing stars). The stream velocity along the X-axis in the neighbourhood of the point L1 amounts 20-30 km/s and is equal to the sound velocity in this point. This result confirms the supposition by Lubow S.H. & Shu F.H.(1975) about the stream velocity in the point L1. In perpendicular direction the stream is in hydrostatical equilibrium (its velocity does not exceed a few hundred m/s). It also agree well with the earlier assumption of Prendergast K.H. & Taam R.E.(1974). The calculated rate of mass transfer reaches 10^{-5} $M_\odot$/yr and also agree well with observed values of the rate of mass transfer.

For V367 Cyg the stream radii calculated on the basis of the system parameters obtained by the different authors, differ considerably. The maximum value of the

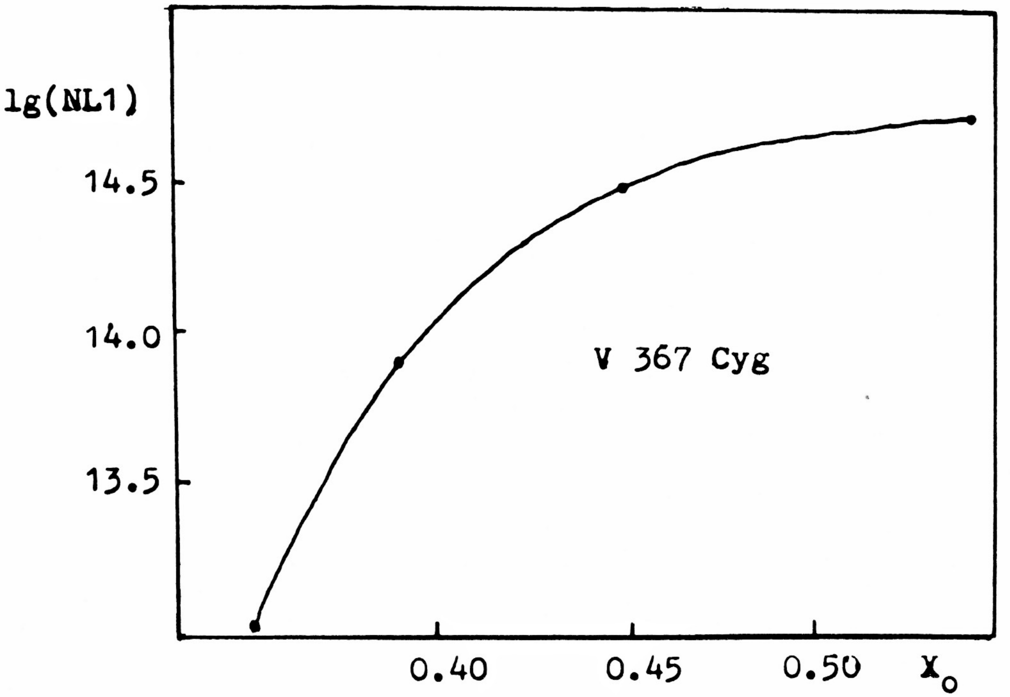

Fig.1

Table 1.Stream parameters in the neighbourhood of the point L1

Xo	XL	NL(cm^{-3})	TL(K)	VL	VL(s)	Rs	R	$\dot{M}(M_\odot/yr)$	Ref.
					β Lyr				
0.38	0.32	$6.4\ 10^{14}$	46000	29.5	27.2	0.15	0.22	$6.4\ 10^{-6}$	Ziolkowski
0.32	0.32	$3.0\ 10^{14}$	32100	23.2	21.5	0.13	0.22	$1.9\ 10^{-6}$	Ziolkowski
0.37	0.37	$3.0 \cdot 10^{14}$	32200	23.7	21.9	0.10	0.25	$1.3\ 10^{-6}$	Skul'ski
					V367 Cyg				
0.54	0.45	$5.2 \cdot 10^{14}$	51780	28.5	26.7	0.19	0.34	$1.8\ 10^{-5}$	Menchenkova
0.45	0.45	$2.8 \cdot 10^{14}$	37000	25.0	23.5	0.17	0.34	$6.1\ 10^{-6}$	Menchenkova
0.39	0.45	$8.0 \cdot 10^{13}$	23200	19.7	18.5	0.14	0.34	$9.1\ 10^{-7}$	Menchenkova
0.44	0.44	$3.8 \cdot 10^{14}$	23043	19.3	17.9	0.14	0.33	$4.0\ 10^{-6}$	Pavlowski et al.
0.54	0.55	$2.7 \cdot 10^{14}$	36300	25.0	23.5	0.10	0.42	$1.0 \cdot 10^{-6}$	Li et al.
					RY Sct				
0.40	0.39	$1.4 \cdot 10^{15}$	69100	32.3	30.8	0.15	0.27	$1.0 \cdot 10^{-5}$	Antokhina et al.
0.33	0.39	$2.0 \cdot 10^{13}$	19344	19.1	16.3	0.08	0.27	$2.2 \cdot 10^{-8}$	Antokhina et al.

stream radius and the rate of mass transfer were calculated by using the parameters of the system obtained by Menchenkova E.V.(1990). The stream radius and the rate of mass transfer calculatedd on the basis of the parameters from Pavlowski K. et al.(1992) and Li Y.-F. et al.(1987) are smaller. That fact contradicts to the observational data about the existence of circumstellar matter with develope structure in the system V367 Cyg. That is why, we draw the conclusion that for V367 Cyg the parameters obtained by Menchenkova E.V.(1990) are more realistic: M1= 2.3 $M_\odot$, M2= 3.6 $M_\odot$, T1= 12000 K, A= 53 $R_\odot$.

For β Lyr the maximum values of the stream radius and the rate of mass transfer obtained for the system parameters calculated by Ziolkowski J.(1976): M1= 2.0 $M_\odot$, M2= 11.7 $M_\odot$, T1= 11000 K, A= 55 $R_\odot$.

For RY Sct the stream radius calculated on the basis of the different variants of the system parameters are equal.

More detailed report will be published in Astronomicheskij Zurnal (Moscow)

REFERENCES

Antokhina, E.A., Cherepashchuk, A.M., 1988, Pisma Astron.Zu. 14, 252.

Belotserkovskij, O.M., Davydov, Yu.D., 1982, Method of the large particles in the gasous hydrodinamic. Nauka. Moscow.

Kurucz, R.L., 1979, Ap.J.Supp.Ser. 40, 1.

Li, Y.-F., Leung, K.C., 1987, Ap.J. 313, 801.

Lubow, S.H., Shu, F.H., 1975, Ap.J. 198, 383.

Menchenkova, E.V., 1990, Astron.Zu. 67, 653.

Nazarenko, V.V., 1993, Astron.Zu. 70, 12.

Pavlowski, K., Schneider, H., Akan, M.C., 1992, As.& Ap. 258, 329.

Prendergast, K.H., Taam, R.E., 1974, Ap.J. 189, 125.

Skul'skij, M.Yu., 1975, Astron.Zu. 52, 710.

Ziolkowski, J., 1976, Ap.J. 204, 512.