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Be star binary systems with non-compact secondaries

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In close binary systems with a Be star and a non-compact star, interesting phenomena happen when the Be star ejects gas. In a detached system, the gas from the Be star, as it expands, can form a circulatory stream along the critical Roche Lobe, besides overflow through the inner Langrange point (see Figure). In semi-detached systems, where gas from the secondary fills the Roche Lobe and overflows through the inner Langrange point, the gas stream will interact with the gas disk from the Be star, if the Be star is in its Be-phase. If the Be star is in its B-phase, the gas from the secondary may form a disc around the Be star and the accreting gas may induce ejection of matter from the Be star. The gas from the secondary may in some cases directly hit the Be star surface and produce a hot region. We thus provide a framework using which, models of individual systems may be constructed. The considerations are applied to HR 2142 and 17 Leporis as examples and presented elsewhere.

Phenomena in close binary systems are best understood in the Roche picture (Kopal, 1959). Lubow and Shu (1975) have discussed various regions in binary systems. Near the stars the gravitational and inertial effects dominate. The surface of the Roche Lobe constitutes the second flow region. The third region is the neighbourhood of Li, where pressure effects are of the same order as inertial and gravitational effects. The fourth region is the transonic shell which is a dynamic shell surrounding the Roche limit of the detached components. The dimensions of the different regions depend on the masses of the components and the binary period.

Detached Binaries with Be stars :

A Be star in a detached binary can eject a gas disk. In the initial stages the gas disk will be under the influence of the gravitational force of the Be star and will be symmetric. As it expands, the gravitational force of the other star will be felt and the disk will be distorted. At this stage V/R effects may be seen. As the disk expands further, it will touch the Roche lobe and will enter the L1 region. Matter will overflow into the Roche lobe of the companion. This matter may form an accretion disk around the companion or directly hit the star, depending on the nature of the secondary and the binary period. The expanding disk will now

enter the transonic shell region and will circulate along the Roche potential, in the form of a figure of eight (Figure 1). Further expansion will result of expulsion of the gas through the outer Lagrange point.

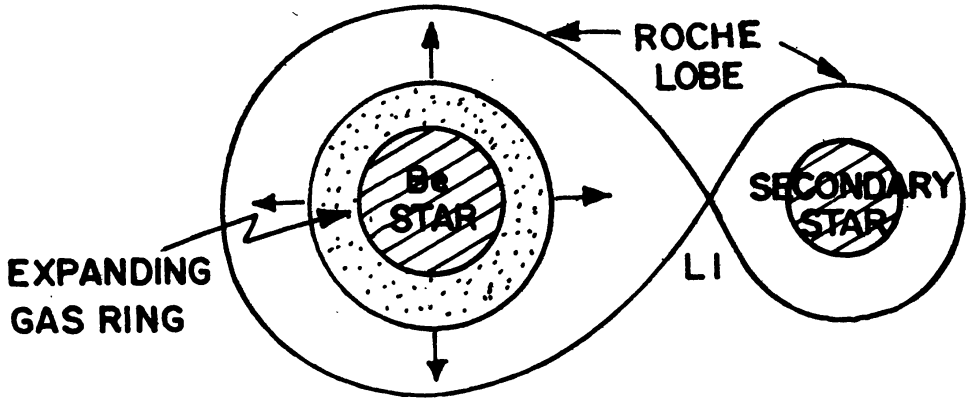

Figure 1a. A detached binary system with a Be star. L1 is the inner Lagrange point. The gas disk ejected by the Be star is expanding, but is still within the Roche Lobe.

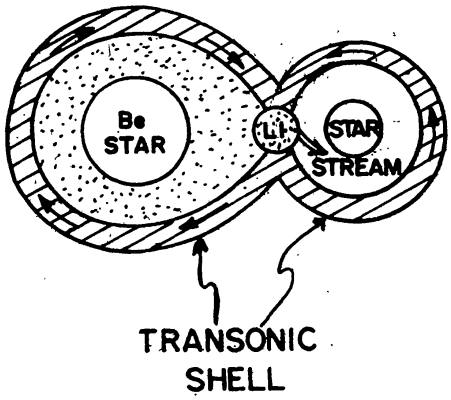

Figure 1b. A detached binary system with a Be star, with the expanding gas disk touchng the Roche Lobe. The circulation of gas in the transonic shell is shown.

Semi Detached Binary Systems with Be stars :

In a semi-detected system with a Be star, where the secondary fills its Roche lobe matter, will flow through L1 and enter the Roche lobe of the Be star. a) If the Be star is in its B-phase and if the dimension of the Roche lobe R_L is large compared to R_B, the size of the Be star, a disk may form around the Be star. If R_B is comparable to R_L the gas stream from L1 will hit the Be star surface. In the case of formation of a disk around the Be star, the gas will slowly accrete but no detectable radiation may be seen due to large R_B. The gas disk may provide angular momentum to the fast rotating Be star and may trigger an outburst of gas

ejection. In the case the stream hitting the surface of the Be star, a hot region will be formed. b) If the Be star is in its Be-phase, the stream from L1 will hit the disk and will form a hot spot. The hot regions may be observed in the optical and ultraviolet at some orbital phases.

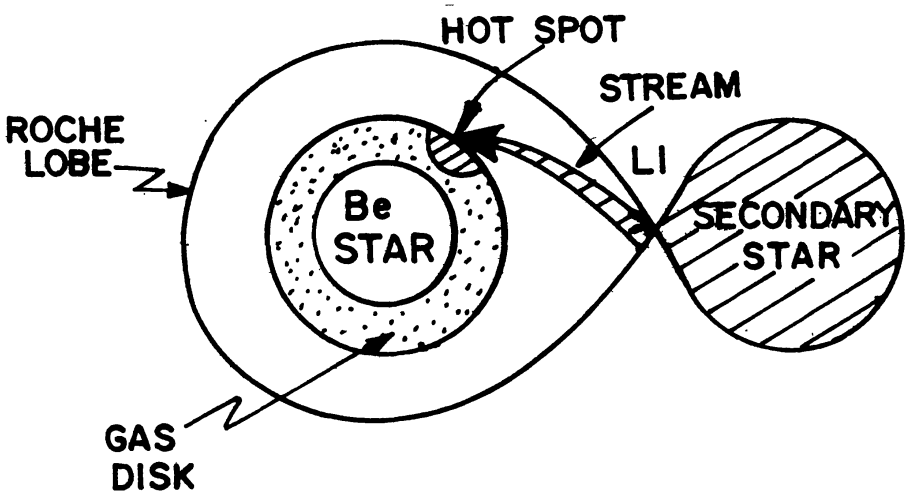

Figure 2a. A semi-detached binary with a Be star and a secondary star filling the Roche Lobe. The overflowing stream through the Lagrange point hits the gas disk forming a hot spot.

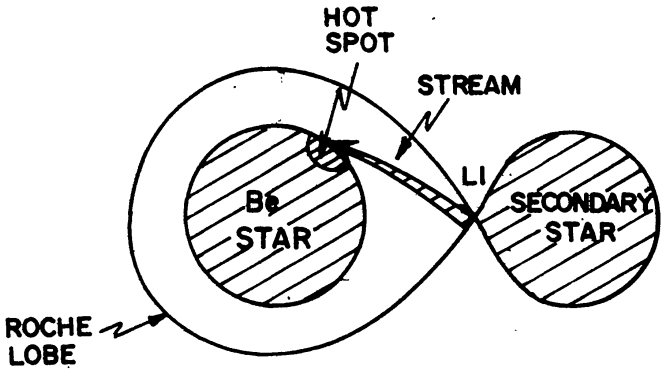

Figure 2b. A semi-detached binary with a Be star and a secondary star filling the Roche Lobe. The overflowing stream hits the Be star.

References

Kopal Z. I., 1959, Close Binary Stars (Chapman & Hall).

Lubow S. H., Shu F. H., 1975, ApJ, 198, 383.