CURRENT OBSERVATIONAL DEVELOPMENT IN EARLY-TYPE CONTACT BINARY SYSTEMS

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This is a summary of current observational results of early-type contact binary systems. The classical approaches to derive a photometric solution of a very close binary are found to be incapable of distinguishing whether a system is detached, semi-detached, or in contact. A survey of contact systems based on the more modern approach of Wilson and Devinney (1971) and others are summarized in the following. Contact systems with spectral type O are: V382 Cyg (Devinney 1976 private communication, Bloomer et al. 1979), V729 Cyg (Leung and Schneider 1978c), UW CMa (Leung and Schneider 1978b), AO Cas (Schneider and Leung 1978); with spectral type B are: SV Cen (Wilson and Starr 1976, Rucinski 1976), V701 Sco (Wilson and Leung 1977, Anderson et al. 1979), BH Cen (Leung and Schneider 1977), RZ Pyx (Devinney 1976 private communication); with spectral type A are: AU Pup (Leung and Schneider 1978a), V1073 Cyg (Leung and Schneider 1978a), V535 Ara (Leung and Schneider 1978a), BV 845 (Leung and Darland 1978), V1010 Oph (Leung and Wilson 1977).

Figure 1 is a diagram showing the relation between the surface potential and mass ratio of the known early-type systems. In cases where the mass ratios were not certain, multiple solutions for different mass ratios were derived. It was found that the solutions remained in contact configuration and the degree of overcontact remained at about the same value. Thus a point in Fig. 1 will shift roughly parallel to the inner or outer contact boundary (Leung and Schneider 1978a and 1978b). It is interesting to note that only V701 Sco and BH Cen have mass ratios about unity.

The majority of the systems are located near the inner contact potential boundary (small degrees of overcontact), but a few of them have contact potentials approaching the outer contact potentials (large degrees of overcontact).

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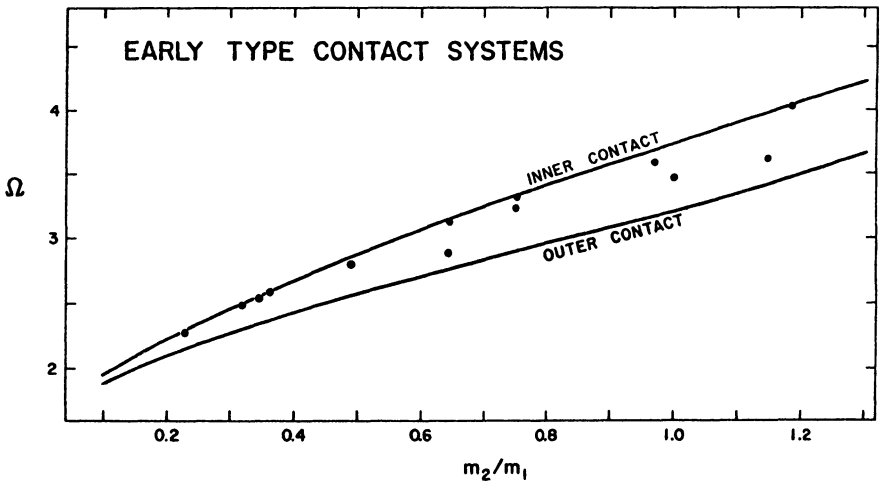

Figure 1. Surface potential - Mass ratio diagram for early-type contact systems.

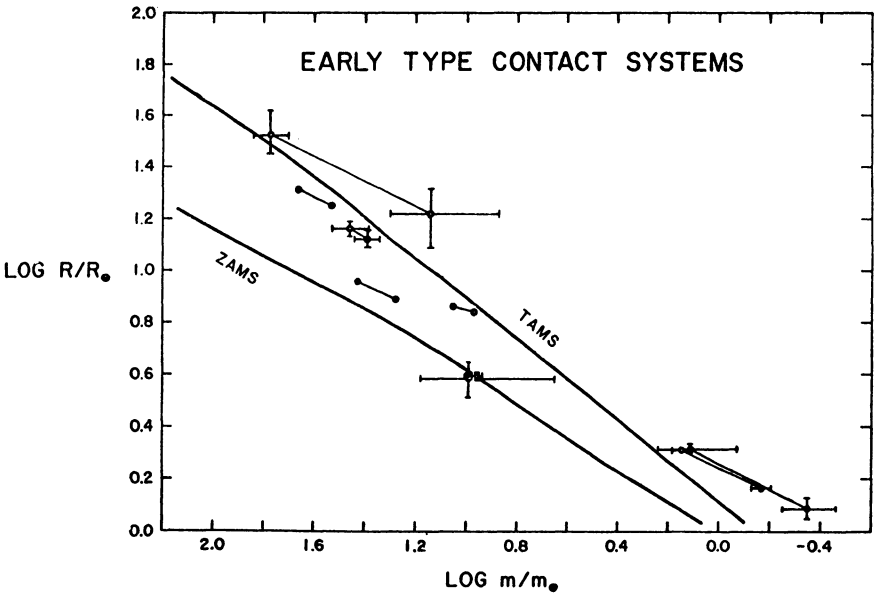

Figure 2. Mass - radius diagram for early-type contact systems.

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More than half of the systems have sufficient spectroscopic information for determination of absolute dimensions of the components of the binaries. Their locations in the log $R/R_\odot$ and log $m/m_\odot$ diagram are shown in Fig. 2 together with the ZAMS and TAMS lines of Stothers (1972). The two systems located near the ZAMS are V701 Sco and BH Cen. (Since the mass ratio of each system is about unity, both components occupy the same location.) They are also members of very young galactic clusters. Their locations in the H-R diagram indicate that they are zero-age systems. It is believed that the systems which fall between the ZAMS and TAMS lines are evolved contact systems through case A mass exchange. The three systems lying above the TAMS line are most likely to be evolved contact systems through case B mass exchange.

It is interesting to note that both of the zero-age systems found so far have mass ratios near unity. Does this mean that only mass ratio of unity is allowed for radiative common envelope zero-age contact systems as Lucy suggested? Obviously, this important question deserves further observational investigation. Hopefully, more zero-age contact systems will be discovered for observational tests between the Lucy and Shu theories. The system TU Mus deserves immediate attention, since, based on its location in the period-spectral type diagram (Leung and Schneider 1978a), this is a potential candidate for a zero-age contact system this system has a mass ratio of 0.67!

It is also appropriate to draw our attention to the system VW Cep even though it is a late type system. This eclipsing binary has a large secondary variation in its light curve. A successful attempt had been made (Leung unpublished), employing a numerical technique, to decouple the observed light curve into a binary light curve and a periodic secondary variation light curve. The binary light curve was analyzed by the Wilson and Devinney method (1971). Two photometric solutions were found (see Fig. 3), a semidetached solution and a detached solution. The latter assumed the gravity darkening exponents and the bolometric albedos equal to unity, which may not be realistic for late type stars. The former solution (semidetached) was derived by letting these coefficients be adjustable parameters. The final adopted values were: $g_1 = 0.6$, $g_2 = 0.7$, $A_1 = 0.3$, and $A_2 = 0.7$. These values are reasonable for late type stars. Therefore, the semidetached configuration solution for VW Cep was adopted. (Note that no contact solution was found even though attempts were made.) Thus, this system may be an example of a system after contact has broken. Lucy's thermal relaxation oscillations theory may be favored in this case!

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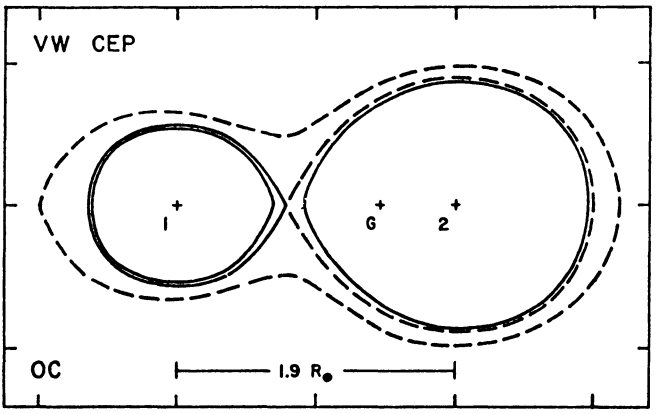

Figure 3. Semidetached and detached configurations of VW Cepei.

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COMMENTS FOLLOWING LEUNG

Linnell: Although I have not seen the details of this solution, I recall the solution of TX Cnc by Wilson and Bierman, using the same light synthesis program. In that case, there were two solutions, one allowing a thermal discontinuity between components, the other producing a hot primary. Especially in the latter case, the gravity brightening coefficient is much larger than even the Lucy theory allows. Is the same true of the VW Cep solution?

Leung: In the case of VW Cep, $g_1 = 0.60$, $g_2 = 0.65$. These values are expected for late type stars.

Anderson: The rotation broadening function for VW Cep, although indicating marginal contact, does fit our atlas entry corresponding to the correct spectroscopic mass ratio. This fit implies that the surface temperature is the same on both stars (in agreement with Dr. Linnell's results) which in turn implies good thermal contact.

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