ABSOLUTE DIMENSIONS OF ALGOL BINARY SYSTEMS

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In order to check the evolutionary status and theoretical models of eclipsing binaries of Algol type, a reliable determination of their absolute dimensions is needed. In this communication, we compare the most commonly used methods to derive absolute parameters in single-lined aclipsing binaries. Let us first assume that the mass function, $f(m)$, is known from the analysis of the radial velocity curve while the relative radii and orbital inclination are derived from the light curve. The determination of absolute parameters is then equivalent to the obtention of the mass ratio, $q = m_2/m_1$. The following methods are available to estimate q from observed parameters -- over-all errors being estimated for observational uncertainties of the order of 5 % in relative radii and temperatures and 15 % in $f(m)$ —:

1. q_S: It is assumed that the primary component follows the mass-luminosity relation for main-sequence stars. This procedure provides q_S with an uncertainty of about 10 %.

2. q_{SD}: It is assumed that the secondary component fills its Roche lobe. Errors of at least 15 to 20 % are expected from this procedure mainly due to its high sensitivity to small variations in the observed value of r_2, particularly if $r_2 > 0.2$.

Both methods can be used together when $f(m)$ is doubtful, or completely unknown, but errors can not be expected to be better than in case 2.

3. q_R: It is assumed that the primary component rotates synchronously in a circular orbit. This assumption is difficult to adopt due to the expected transfer of angular momentum through mass transfer and the value of q_R is estimated with about 20 to 30 % error.

4. q_{ED}: It is assumed that the primary component is well reproduced by standard evolutionary models within the main sequence. Adopting a grid of models for a given chemical composition, an iterative procedure in the $\log T_e - \log g$ plane permits the determination of m_1 and thus q. This method is equivalent to (1) but avoids errors due to evolution from the ZAMS to the TAMS, not taken into account in the previous method, and allows to reach a higher accuracy, around 5 %, except for those primary stars located around the TAMS, where the determination of m_1 is not unique.

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As an alternative, a direct determination of $log\ g_2$ can be made. Using the definition of $log\ g_2$, $f(m)$ and Kepler's law, we can write:

$$log\ g_2 = 3.1897 + \frac{1}{3}log\ f(m) - log\ sin\ i - \frac{4}{3}log\ P - 2log\ r_2$$

which allows us to calculate the surface gravity of the secondary components directly from observable parameters without further assumptions. The expected error in the estimation of $log\ g_2$ is of the order of 0.07.

To check the above given methods for estimating q from the observed parameters of single-lined Algol binaries, we have first selected a subgroup of stars with double-lined spectra for which q is directly observed. The adopted values have been taken from Popper (1980), Giuricin and Mardirossian (1981) and Hilditch and Bell (1987). A comparison of q versus q_S and q_{SD} has been made. A better agreement q is clearly found in the case of q_S and the larger scatter of estimations through q_{SD} is also evidenced in a plot of q_S versus q_{SD}. In this case, a more complete sample of Algol type binaries has been taken adding 49 stars from Budding (1985). Contrary to the suggestion by Budding (1985), the estimation of q by means of the MLR for the primary component is more accurate than that from Roche-lobe filling.

We have also studied the q_R versus q_S plot for the small subset of stars with observed values of $v_1 sin\ i$, both from double-lined and single-lined Algol binaries. A tendency for $q_R < q_S$ in values of $q_S < 0.4$ is observed which indicates a supersynchronous rotation of primary components. It is also found that the relative differences of rotational velocities with respect to synchronization are larger for increasing values of the orbital period but do not depend on spectral type, contrary to the suggestion by Van den Heuvel (1970).

On the other hand, the behaviour of q_{ED} has been compared with the derived value of q_S. The good agreement between both estimators for the whole sample enhances the validity of the assumption that the hotter component of an Algol binary behaves basically like a normal main-sequence star.

Finally, we have plotted the position of the 60 available secondaries of Algol binaries, tabulated by Budding (1985), in the $log\ T_e - log\ g$ plane directly from observational parameters, without any additional assumption using the equation previously given. A good agreement with luminosity classes IV and III is clearly noticed. For double-lined Algol binaries, it is found that the mass tracks corresponding to the position of the cooler components in $log\ T_e - log\ g$ plane are systematically larger than the observed values. This is equivalent to say that mass-loosing components are "over-luminous" for their masses. In terms of surface temperatures differences can be up to 40 % though most cases are below 25 %. It should be also noticed that the larger differences are found for $q < 0.4$ which relates excess luminosity with mass loss/transfer.

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