Session 2. Orbital Parameters (*continued*)

REMARKS ON ORBITS AND DYNAMICAL PARALLAXES

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In connection with statements made at the preceding session, some results presented at the Nice Conference on systematic and random errors affecting the elements a and P as well as a^3/P^2 may be recalled. If many orbits have been calculated for one binary, it is instructive to plot log P, log a, and log a^3/P^2 versus log $\Delta t/P$ where Δt is the time interval covered by observations. As a general rule, when $\Delta t \simeq P$ the systematic trends vanish, and the scatter of the plotted elements reaches a low value, not considerably changing thereafter. It may well be of interest, then, to have several orbits based on the same observations but computed by different authors and methods.

It might be expected that only those orbits based on at least one full revolution of observations would be reliable enough to be included in a study of stellar masses. However, some pairs which lack complete coverage may be equally useful. This is true when the node is well within the observed arc, as van Albada has shown, and the author has demonstrated this by the formula

$$\mathbf{M} = -\frac{1}{4\pi^2 \cos^3 j}\,\frac{g\rho^2}{\pi''^3}$$

for the total mass $\mathbf{M}$, where g is the projected acceleration, ρ the separation, π'' the parallax, and j the angle between the true and the projected radius vectors.

In the study of the mass-luminosity relationship, for example, one might consider only well-determined orbits or might employ a wider selection of orbits at the expense of somewhat larger errors. This question deserves some careful attention.

The terminology on dynamical and hypothetical parallaxes is confused in the literature. All parallaxes defined by some dynamical relationship (the harmonic law, or expressions for the velocity or the acceleration) could be termed *dynamical* yet a distinction between orbital (harmonic law) and non-orbital values could be considered. Another proposal arises if we try to follow closely the methods used by earlier authors: a *theoretical parallax* is defined by the assumption that the total mass $\mathbf{M}$ is $M_\odot$ (for use in some mathematical derivations), a *hypothetical parallax* by the hypothesis $\mathbf{M} = 2M_\odot$ (which is about the average found in visual doubles) and a *dynamical parallax* by the use of the mass-luminosity array.

In designating a parallax as orbital or non-orbital (each of the three

https://doi.org/10.1017/S0252921100150353 Published online by Cambridge University Press

classes may be either), the word "dynamical" is perhaps redundant and could be reserved for the overall meaning.

Let us consider now the methods used to compute dynamical parallaxes, and ask which differences between the Russell-Moore and the Baize-Romani formulae are merely apparent, and which are basic?

For the orbital parallaxes, both approaches proceed from the harmonic law and the mass-luminosity relationship which provide two equations for the two unknowns (total mass and parallax), so they are not fundamentally different. In the theoretical derivation a difference does occur, one approach leading to the Baize-Romani equation, the other to a formula akin to Russell's 1928 equation and still more similar to the 1940 formula by Russell and Moore, viz.

(1) $$\log \eta = 0.0500\,(M_{AB} + B' + D' - 7.27)$$

when applied, for instance, to main-sequence stars. The corresponding theoretical equation reads:

(2) $$\log \eta = 0.0500\,(M_{AB} - \kappa - 5.20)$$

where $\eta = \mathbf{M}^{-1/3}$. B' is a function of the quality of the orbit, D' depends on the difference of visual magnitudes and spectra while κ is a function of the bolometric magnitude difference only. [*Note by editor*: κ is not related to the κ used by Baize and Heintz.] Now there is an inconsistency in the Russell-Moore method, the total mass obtained from the harmonic law differs by 5 or 10 per cent from the sum of the masses computed via the mass-luminosity law. The use of relation (2), however, leads to a complete agreement of the masses obtained, without sensibly altering the parallax. Therefore, the use of "empirically revised" expressions serving merely to make results consistent without improving the parallaxes seems pointless.

The Baize-Romani formula is superior in this respect and is, in the author's opinion, simpler to use. In practice, the methods will also differ by using different bolometric corrections and mass-luminosity relationships.

A final comment relates to the shape of the mass-luminosity array which is perhaps non-linear. Will the methods mentioned remain valid in this case? The author believes they will, since any departure from a straight line is a function of the masses or of the luminosities, hence a function of the spectral type, and can be incorporated in the bolometric correction term.

Discussion

Referring to previous conference reports (Nice and Charlottesville 1969), Heintz objected to names such as Baize-Romani parallax as being somewhat incomplete and ambiguous. The method can be used in conjunction with any mass-luminosity array. This generalized use permits, and is needed, to take the well-known non-linearity of the empirical relation into account.