SPECTROSCOPIC OBSERVATIONS OF VISUAL DOUBLE STARS

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ABSTRACT. Observations of visual binaries made with the 1.2-m telescope and coudé spectrograph at Victoria are described, with particular emphasis on their value as tests of evolutionary calculations.

1. INSTRUMENTS

Over a number of years, the writer and colleagues have used the 1.2-m telescope at Victoria and its coudé spectrograph, either photographically or in conjunction with a radial-velocity spectrometer (e.g. Griffin 1967) to observe visual binaries. With a telescope of a given aperture, a spectrometer reaches fainter (and more) stars than the photographic plate, at the cost of some of the information that a high-dispersion photographic record can give. Ideally, a spectrometer might be the principal instrument used in this work, but its results should be supplemented, whenever possible, by spectrograms or other observational records that permit the examination of individual line profiles.

2. STARS OBSERVED

Several different groups of visual binaries may usefully be observed spectroscopically. The most interesting are pairs of stars of nearly equal luminosity for which there is a well-determined visual orbit of such a shape and orientation that large differences in the radial velocities of the two components may be expected around nodal passage. Most pairs in this class will be so close that their images are indistinguishable from those of single stars at the spectrograph slit. A given binary, with a period of decades, is therefore likely to be of interest for about a couple of years, at most twice in an observer's active career. Nevertheless there are enough systems for a long-term programme that could be a useful part of a small observatory's work. The Catalogue by Dommanget and Nys (1982) is of considerable value in selecting systems for observation, although the necessary computations may easily be made directly from the orbital elements.

Although radial-velocity differences of the order of 100 km s^{-1}

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occasionally occur, even between the components of quite long-period binaries, differences of the order of 20 km s^{-1} to 30 km s^{-1} are much more common. Most systems observed must have both components of late spectral type, if the spectra are to be resolved. Observational selection already favours this kind of system. We have found that velocity differences of about 20 km s^{-1} can be accurately measured with our spectrometer and pairs of about sixth magnitude or brighter can be observed with a photographic dispersion of 2.5 Åmm^{-1} at even smaller velocity separations.

3. LIKELY RESULTS AND THEIR USEFULNESS

The principal results from these observations are the parallax and total mass of each system. Quite accurate parallaxes, beyond the range of trigonometrical measurement, can be obtained from only a few measurements (in principle, one) of radial-velocity difference. The total mass of a system can also be found accurately, although mass-ratios, and therefore individual masses, are usually harder to determine because of uncertainty in the systemic velocity. Popper (1980) lamented that "the very great amount of difficult observing [of visual binaries] for more than 150 years" has resulted in no more than a dozen or so masses being known even to within 20%. The kind of observation described here is one way of making use of that 150 years' work and increasing the number of systems for which both masses and luminosities are well known.

Of particular interest, however, is the surprising number of visual binaries that contain components not on the main sequence. Amongst nine visual binaries (including two interferometric ones) studied at Victoria, five or six contain at least one component above the main sequence. For these components, we know mass, luminosity and temperature with a fair accuracy (e.g. Batten *et al*. 1982). In time, it should be possible to amass enough data to provide even more useful checks on evolutionary models of stars than are obtained now from observations of star clusters.

Two or three groups are now making this kind of observation in the northern hemisphere. The rate of progress could be substantially increased if a suitable telescope in the southern hemisphere were used for similar work.

4. REFERENCES

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DISCUSSION

Evans: Did you observe only those pairs with good visual orbits?

Batten: Yes, of course, I should have made that clear.

Kurtz: 1) Why can't you see the secondary in 70 Oph better since the masses of the two stars are similar? 2) What is the orbital eccentricity of OΣ 341?

Batten: 1) Immediately before and after nodal passage, the two components of 70 Oph cannot be resolved on the slithead at Victoria. Also the brighter component dominates the spectrum.
2) The orbital eccentricity of OΣ 341 is 0.96.

Garrison: There are other ways in which visual binaries are useful as tests of stellar evolution theory. Corbally has studied very close pairs (1"-5") with our 60cm in Chile using MK classification techniques. His results are published in an Ap. J. Suppl. and in the IAU Symposium Obs. Tests of Stellar Evolution Theory. He was about to put constraints on Demarque's latest models.

Batten: Chris Corbally's work is, of course, important, but orbital pairs do give you extra information: the masses of the components.

Evans: The Texas group has been working on triple systems from which you can extract much information. For example, one can get the equivalent of a visual orbit, using speckle or occultation measurements. We have done some of the binaries in the Hyades in this way.

Batten: Yes, other groups, including yours are doing similar work; but there is still no-one working in the southern hemisphere - where there are a lot of good stars to do.

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