V. ALGOL AND ALGOLS

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Spectroscopic Orbits of Algols--a Progress Report

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Preliminary values of masses and radii are presented for twelve Algol systems with cooler components of class F or later. The results are new for nine of the systems and are based on measures of the D lines for the faint cooler components. For most of the systems with periods longer than six days the orbits of the hotter components are uncertain because of absorption by non-photospheric matter in the systems. The masses of the hotter components are approximately normal for their spectral types, while the masses of the Roche-lobe filling components range from 0.2 to 1.4 solar masses.

This discussion is restricted to semi-detached binaries of the "typical" Algol class in which the secondaries are of type F or later and for which radial velocities of the secondaries have been obtained outside eclipses. Velocities have been published for both components of three of these systems: AW Peg (Hilton and McNamara 1961), AS Eri (Popper 1973), and Algol itself (Tomkin and Lambert 1978). Observations at the Lick Observatory making use of an image tube giving a reciprocal dispersion at the D lines of 11 Å mm^{-1} are in various stages of completion for a number of additional systems in which the D lines and, in a few cases, some additional lines of the secondaries can be measured outside eclipses on spectrograms of high contrast. The Texas reticon work on Algol illustrates the potential of modern detectors, at least on bright stars.

To obtain masses and radii, the orbits of the primaries must be obtained as well. For a majority of the relatively bright systems under discussion velocities of the parimaries have been published by others. For the systems with periods less than about 6 days (Algol, TW And, RY Aqr, TW Dra, AS Eri, RS Vul) the orbits appear to be without complications. On the other hand, for most of the systems with longer periods (RY Gem, TT Hya, AW Peg, RY Per, XY Pup), the velocities appear, to a greater or lesser degree, to depart from the sinusoidal variations shown by the secondaries. S Cnc, $P=9^{d}.5$, may be an exception. As in the well-known cases of U Cep and U Sge, the distortions of the velocity

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curves may be a result of absorption in gas streams in the systems. The distortions are not, however, necessarily to be attributed to alterations of the line profiles. The velocities of TT Hya, for example, are based on internally consistent measures of a considerable number of symmetrical lines with not particularly broad profiles. These lines vary in intensity around the orbit. Additional evidence of extra-photospheric matter is to be found in the strong double Hα emission in the spectra of all the longer period systems except S Cnc and, in some cases, the weakness of Mg II 4481. A study of all these effects may provide information about the physical properties of the extra-photospheric matter as well as of its distribution and motion.

The table gives provisional values of the masses and radii of the components of Algol systems. The uncertainties in the values are consequences of inadequate observational material obtained to date and, in most of the longer period systems, of distortion of the velocity curves of the primaries by non-stellar matter.

			Hotter		Cooler	
	P	Sp	$M(H_\odot)$	$R(R_\odot)$	$M(M_\odot)$	$R(R_\odot)$
RY Aqr	2.0 d	A5	1.3	1.5:	0.3:	1.7:
AS Eri	2.7	A3	1.9	1.8	0.2	2.2
TW Dra	2.8	A3	1.7	2.4	0.8	3.4
Algol	2.9	B8	3.7	3.1	0.8	3.2
TW And	4.1	A8	1.8	2.2	0.4	3.4
RS Vul	4.5	B5	4.5	4.1	1.4	5.6
RY Per	6.9	B4	5:	3.4	0.8::	7
TT Hya	7.0	A2	2.6:	2:	0.7::	5:
RY Gem	9.3	A2	2.6	3.3	0.6:	6
S Cnc	9.5	AO	2.4	2.1	0.2::	5
AW Peg	10.6	A5	2.0:	---	0.3::	---
XY Pup	13.8	A2	2.3:	---	0.3::	---

The masses and radii of the primary components lie within the range for main sequence stars of the same spectral types with the exception of TW And, which appears cooler than its mass and radius would predict. The secondary masses show no clear correlation with other properties. Masses as low as 0.2 or 0.3 do not appear to be uncommon in Algol systems. These results must play a role in improving our understanding of the evolutionary histories of Algol systems. We heard at considerable length earlier in the symposium of difficulties in understanding their histories.

REFERENCES

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DISCUSSION FOLLOWING POPPER

Whelan: Have you found any problems with image tube systems when measuring radial velocities?

Popper: No matter what spectrographic configuration is used, standard-velocity stars should be observed frequently; with the Varo image tube at the Lick 120-inch coude', I find no greater systematic or accidental effects in the velocities than when using direct photographic recording.

Wilson: Lately the situation with regard to determing mass ratios from light curves has improved considerably for semi-detached systems, where the size of the secondary tells you the size of the Roche lobe. Although this method does not always give extremely accurate mass ratios, there are also pitfalls in the double-line velocity approach (as you just pointed out) so it should probably be used more than in the past.

Popper: Reliable masses from any source should not be overlooked. As long as one is clearly aware of the potential pitfalls and does not underestimate the uncertainty of the results, a mass ratio obtained through light-curve analysis could be useful in favorable circumstances.

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