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The Spectroscopic-Speckle Triple System HR 6469

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HR 6469 consists of an evolved G5 star and a close pair of fainter stars, probably both on the main sequence. The period of the close pair is just over two days, and shallow eclipses have been detected (Boyd *et al.* 1985), although no analysis of the light curve has been published. The wide system has a period of about 5.5 years, and has been resolved by speckle interferometry (McAlister *et al.* 1983). The G5 star and the primary of the close pair are detectable in the spectrum, with the latter showing modest rotational broadening. Spectral types and rotational velocities for the evolved star and the brighter component of the close pair have been published by Strassmeier & Fekel (1990).

Radial velocities of the spectroscopically detectable components of HR 6469 have been measured by Bolton and Lyons from digitized DDO cassegrain photographic spectra, by Fekel and Rees from coudé spectra recorded digitally at McDonald and KPNO, and by Scarfe with the DAO RV spectrometer.

The HR 6469 system has been observed interferometrically since its first resolution, and the phase coverage is now satisfactorily uniform. Most of the published data have been collected by McAlister & Hartkopf (1988), and two more recent observations have been published by McAlister *et al.* (1990).

Orbital solutions of the available data for HR 6469 have been obtained by means of programs developed by Barlow (Barlow & Scarfe 1991). Because the velocities of the G5 star are much better determined than those of the F2 star, the former alone were used with the speckle data for a three–dimensional solution of the wide pair. The velocities of the F2 star were then solved simultaneously (the three–body solution) for the short–period elements and the amplitude of the long–period variation of the close pair's center of mass, with the other elements of the long-period orbit adopted from the three–dimensional solution. Resulting elements are given in Table 1. Figure 1 presents velocity curves for each subsystem, while Figure 2 shows the ellipse fitted to the speckle data.

Table 2 presents information about HR 6469 derived from the elements in Table 1. The distance to the system and the absolute visual magnitude for the combined light are found from the linear and angular values of the major axis of the relative orbit. Approximate individual absolute visual magnitudes are inferred by interpolating the magnitude difference between the components published by Strassmeier and Fekel (1990). The close pair together are nearly a magnitude more luminous than average for a star of class F2V, and the evolved G5 star appears to have a luminosity close to that of a class III giant, despite those authors' G5 IV classification.

TABLE 1. Orbital Elements of HR 6469

	Wide Pair	Close Pair
Period (days)	2018.1 ± 0.8	2.229636 ± 0.000003
HJD of periastron	2444545.8 ± 0.8	
HJD of nodal passage		2245839.261 ± 0.002
Velocity amplitude of F star ($km\,s^{-1}$)	13.1 ± 0.5	93.6 ± 0.4
Velocity amplitude of G star ($km\,s^{-1}$)	18.36 ± 0.08	
Systemic velocity ($km\,s^{-1}$)	−3.32 ± 0.04	variable
Eccentricity	0.672 ± 0.002	0.0 (assumed)
Argument of G star's periastron	220°.8 ± 0°.4	
Inclination	56°.3 ± 0°.5	
Position angle of node	323°.5 ± 0°.3	
Major semiaxis of relative orbit	0″.0751 ± 0″.0006	

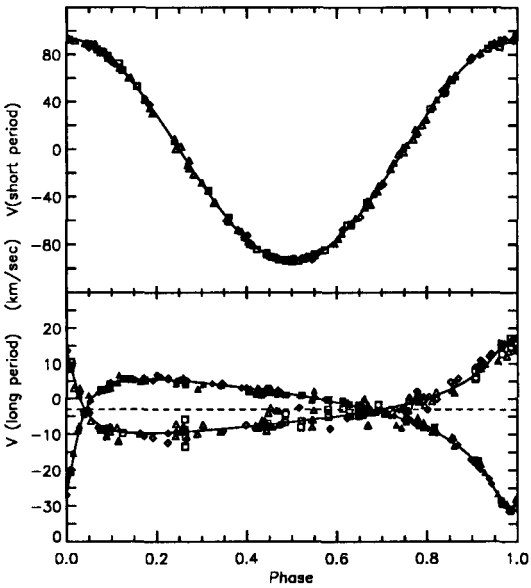

FIGURE 1. Radial velocity curves of HR 6469. The upper part shows the short-period variation of the F star, with the curve derived from the 3-body solution. The lower part shows the long-period variation of the G star (solid symbols, with curve from 3-D solution), and of the centre of mass of the close pair (open symbols, with curve from 3-body solution). Triangles, squares, and diamonds represent DDO, McDonald & KPNO, and DAO data, respectively.

TABLE 2. Physical Properties of HR 6469

Distance (pc)	69.1 ± 1.2
Absolute visual magnitude (combined)	1.31 ± 0.04
Absolute visual magnitude (G star)	1.86
Absolute visual magnitude (close pair)	2.31
Mass of G star ($\mathcal{M}_\odot$)	1.91 ± 0.10
Mass of close pair ($\mathcal{M}_\odot$)	2.68 ± 0.13
Mass of F star ($\mathcal{M}_\odot$)	1.55 ± 0.13
Mass of third star ($\mathcal{M}_\odot$)	1.12 ± 0.04
Angular momentum of wide pair (J_L) ($\mathcal{M}_\odot\,(au)^2y^{-1}$)	25.2
Angular momentum of close pair (J_S) ($\mathcal{M}_\odot\,(au)^2y^{-1}$)	1.44
R.A. of J_L vector	2^h34^m
Dec. of J_L vector	+1°.3

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The long–period elements yield the primary's mass and the total mass of the close pair. The G5 star's mass, like its luminosity, indicates that it is a giant, suggesting that its main-sequence progenitor was a late A-star.

The orbital inclination of the close pair must lie between 75 and 88 degrees to be consistent with the occurrence of partial eclipses and with the stars' likely radii. As a result, the stellar masses are strongly constrained by the total mass and the mass function. They are appropriate for main sequence stars, and consistent with our inability to detect the companion's spectrum, especially since its lines should be rotationally broadened.

The data also suffice to calculate the magnitudes of the angular momenta of the long– and short–period orbits, and the orientation of the first of these vectors. The different inclinations show that the orbits cannot be coplanar.

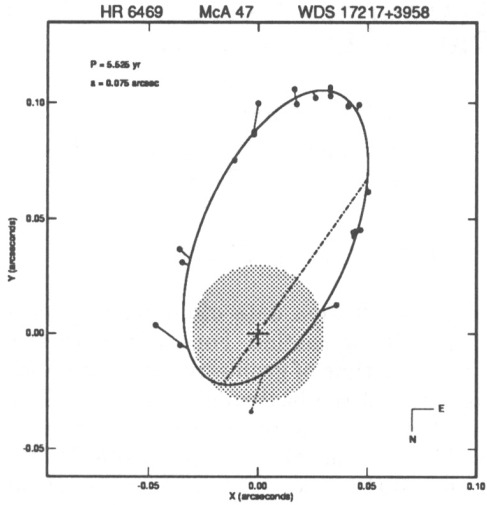

FIGURE 2. Speckle data for HR 6469, with the apparent ellipse which represents elements obtained from the 3-dimensional solution. Solid symbols represent CHARA data, open symbols are observations by Balega, listed in McAlister & Hartkopf (1988).

The most useful next step toward a definitive model of HR 6469 would be a solution of the eclipse light curve. It would also be worthwhile to try to improve the quality of the radial velocities of the F2 star, and to search again for the spectrum of its close companion, presumably in the red, but both these efforts will require observations of high signal–to–noise ratio. Nevertheless such observations would be of great value in refining the masses, which itself is the more worthwhile because of the presence of an evolved star in the system.

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