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HD 54549: A NEW DOUBLE-LINED ECLIPSING BINARY

HD 54549 (BD -22° 1714, CD -22° 4063, α_{2000} = 7^{h}08^{m}21^s.8, δ_{2000} = -22°24′11″) is a ninth-magnitude A star in Canis Major. Houk & Smith-Moore (1988) classify it as A1 III, but both our spectra and *uvby* photometry show it to be a main-sequence star near A8. It is only ~2′ distant from the double-lined eclipsing binary SW CMa (HD 54520) of similar magnitude and spectral type, and, in fact, on the AAVSO chart of the field HD 54549 is erroneously identified as SW CMa itself. Thus, during a program in 1988-89 to determine the spectroscopic orbit of SW CMa with the Center for Astrophysics echelle system (Latham 1985) on the 1.5-m Wyeth reflector of the Oak Ridge Observatory in Harvard, Massachusetts, several spectra of HD 54549 were inadvertently obtained by those conscientious observers who consulted the chart.

The confusion was not immediately obvious since HD 54549 turned out also to be a double-lined spectroscopic binary of almost identical spectral type, luminosity ratio (close to unity), rotation, and velocity variation as SW CMa. Only the steadfast refusal of HD 54549 to follow the radial-velocity variations of SW CMa led to a determined search for the cause of this unusual dynamical phenomenon and eventually to the correct explanation. Observations then continued until the spectroscopic orbits had been determined as shown in Fig. 1.

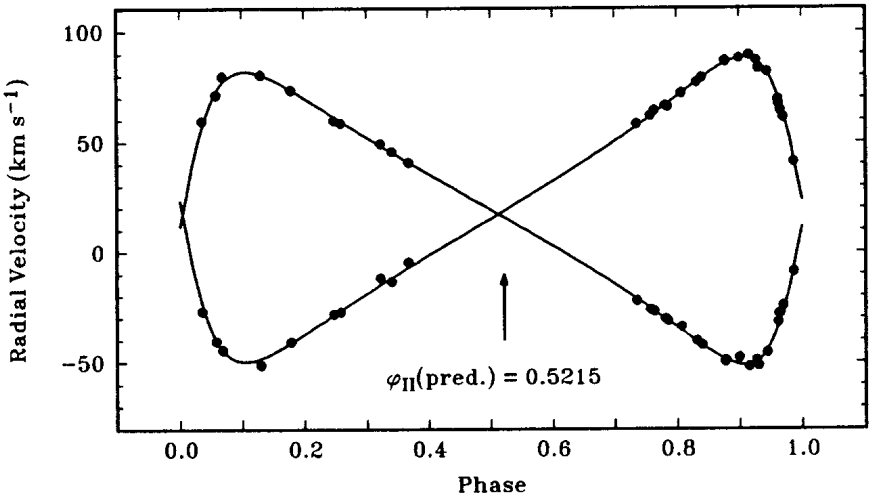

Fig. 1. Preliminary spectroscopic orbit for HD 54549 (Oak Ridge echelle spectra).

From these observations, we determine a period of 21.1175 ± 0.001 days. The orbital eccentricity is rather high ($e = 0.500 \pm 0.003$, $\omega = 86.^{\circ}8 \pm 0.^{\circ}7$), and $a \sin i = 48.7\ R_{\odot}$. The mass ratio is $q = 1.034 \pm 0.008$ and the minimum masses, 1.74 and 1.80 $M_{\odot}$, close enough to those expected for unevolved late A stars (e.g. Andersen 1991) that a search for eclipses was deemed worthwhile. From the spectroscopic orbit, the time of a possible eclipse during the first observed orbital cycle was computed to be JD 2 447 507.051. Since the orbit is seen almost exactly along the major axis, conjunction occurs at an orbital phase only $0.^{d}0027$ after periastron when the stars are closest together, and eclipses should occur for $i \geq 83^{\circ}$. At apastron, the separation is three times as large; $i \geq 88^{\circ}$ is required, and (secondary) eclipses thus much less likely to occur; their predicted phase is $0.^{d}5215$.

During the course of several photometric campaigns in 1989-91 with the Danish 50-cm Strömgren Automatic Telescope (SAT) located at ESO, La Silla, Chile, HD 54549 was observed in the *uvby* system, using the SAT six-channel photometer and the comparison stars (HR 2755 and HD 53123) selected earlier for the nearby SW CMa. Finally, on March 8, 1992, an eclipse was predicted at UT 3.14 ($\pm 1^{h}20^{m}$); it obliged by promptly occurring at UT 3.55, reaching a depth of $0.^{m}13$ in all four colours and a duration of ~ 5 hours (see Fig. 2). The star has so far been found constant at all other times. ~ 80 points on the light curves have been obtained up to now, with typical photometric errors of $0.^{m}005$ in *vby* and $0.^{m}007$ in *u*.

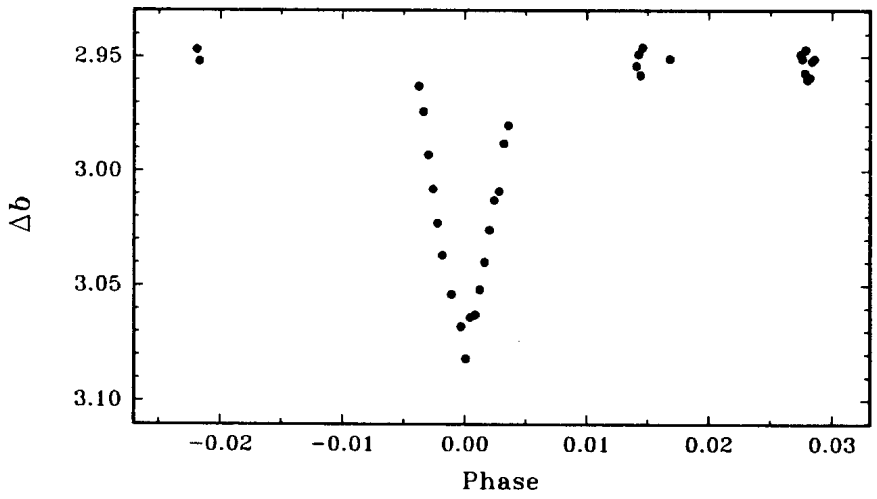

Fig. 2. *b* light curve of HD 54549 near the time of the predicted eclipse (SAT data).

The shape and phasing of the observed light variation leave no doubt that HD 54549 is an eclipsing variable. In order to better understand the properties of the system, preliminary solu-

tions of the incomplete light curve have been made for a set of fixed values of inclination i and ratio of the radii, k, and adopting the spectroscopic values of q, e, and ω.

The resulting luminosity ratio is a steep function of i; the spectroscopic line ratio ($W_B/W_A \approx 0.9$) therefore is a strong constraint on the photometric solution. We find $i \sim 85°$ and relative radii $r_A \approx r_B \approx 0.034$; *no* secondary eclipse is predicted to occur for these parameters. With these elements, the stars are unevolved (log $g \sim 4.25$). The classification A1 III by Houk and Smith-Moore (1988) was probably caused by unrecognized double lines. Combining the observed time of minimum (1992) with the early (1988) spectroscopic prediction, we derive the following ephemeris for primary eclipses (only):

$$\text{Min(I)} = \text{HJD } 2\,448\,689.648 \pm 2 + 21^{d}1178 \pm 5 \cdot E \qquad (1)$$

uvbyβ indices of HD 54549 on the standard system were determined in 1989 as follows (phase interval $0^{p}75$ - $0^{p}85$):

y	b-y	m_1	c_1	β
9.188; ± 3	0.130; ± 2	0.220; ± 2	0.848; ± 10	2.835 ± 10

These correspond to stars of spectral type near A8 and effective temperatures of ~8000 K.

Observations of HD 54549 will continue for a full determination of the absolute dimensions of its components; given the rather long period, this is likely to take a few more years.

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