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DISCOVERY OF VARIABILITY IN HR 9024

HR 9024 was placed on a list of bright suspected variable stars by Hall (1983) because the moderately strong Ca II H and K emission reported by Cowley and Bidelman (1979) suggested it might be an RS CVn-type binary and therefore variable as a result of starspot activity. Feldman (1982) has detected HR 9024 as a radio source and Bopp (1984) has obtained a spectrum which shows the H and K reversal clearly. The absence of detectable radial velocity variation by Feldman and the absence of detectable rotational broadening by Bopp prompted them to consider HR 9024 might be an FK Com-type star seen nearly pole-on. The spectral type is G1 III e .

We obtained UBV photometry on 154 different nights in 1982, 1983, and 1984 using HD 223848 as comparison star. Hopkins used an 8-inch telescope, Boyd a 10-inch. Most of the Boyd data have been published already (Boyd, Genet, Hall 1984ab, 1985); the Hopkins data and the latest Boyd data will be published later. The first five columns in Table I give the median epoch, the observer, the bandpass, the number of nights observed (m), and the number of mean differential magnitudes (n), for various groups of data. The Hopkins means include 1-to-4 individual differential measures; the Boyd means all include 3.

It was obvious even from the 1982 data that HR 9024 was variable, with a total amplitude of about $0^m.02$. For each group we determined the best period by making a series of least-squares sinusoidal fits and the uncertainty of each period by chi-squared analysis. These values are given in the sixth column of Table I. An average of the seven values suggests a period of P = $23^d.2 \pm 0^d.3$.

Then sinusoidal fits were made again using the same ephemeris

$$JD = 2,445,250.0 + 23^d.2\ n \qquad (1)$$

for all groups, the initial epoch in this equation being arbitrary. The last three columns of Table I show the resulting total amplitudes in magnitude units (Δm), the phase of minimum light (θ_{min}), and the rms deviation of a single point (σ_1). One of the light curves, based on Boyd's late-1984 V-band data, is shown in Figure 1 as an example.

TABLE I

Analysis of the Seven Data Groups

⟨JD⟩	Obsv.	λ	m	n	Period	Δ m	θ_{min}	σ_1
2,445,309	Hopkins	V	49	49	$24^{d}.6 \pm 0^{d}.4$	$0^{m}.020$	$0^{P}.427$	$\pm 0^{m}.007$
2,445,681	Boyd	V	64	83	23.6 ± 0.4	0.018	0.704	±0.008
2,445,681	Boyd	B	64	83	22.6 ± 0.4	0.019	0.723	±0.008
2,445,681	Boyd	U	64	83	22.4 ± 0.5	0.019	0.752	±0.009
2,446,018	Boyd	V	41	42	23.0 ± 0.5	0.036	0.591	±0.006
2,446,018	Boyd	B	41	42	22.6 ± 0.5	0.035	0.599	±0.007
2,446,018	Boyd	U	41	42	23.4 ± 0.6	0.041	0.612	±0.010

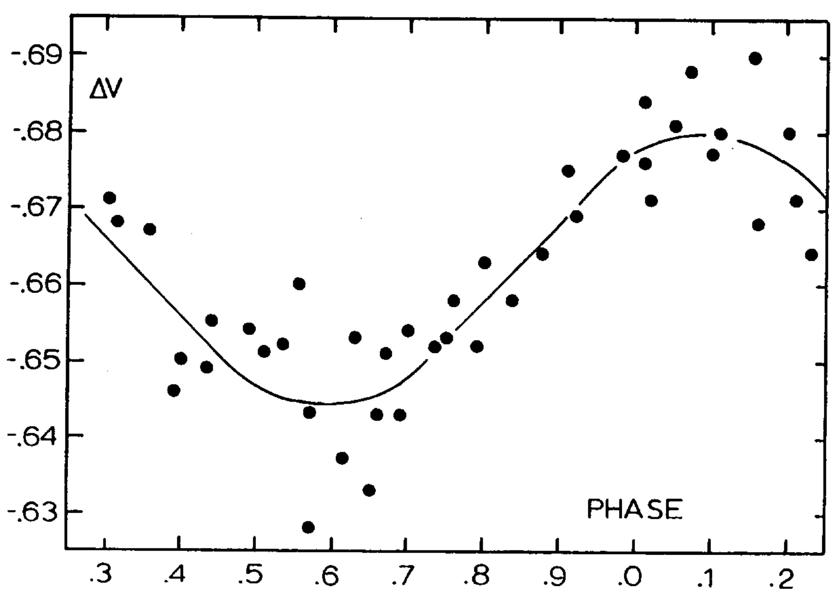

Figure 1

Light curve of HR 9024 based on Boyd's late-1984 V-band data. Phase is computed with the ephemeris in equation (1). The amplitude is $\Delta V = 0.036$ magnitude and minimum light falls at phase 0.59, as indicated in Table I. The rms deviation of the points from the curve is only ±0.006 magnitude.

To take advantage of the 2.2-year baseline in our photometry, we examined the seven θ_{min} values in Table I. A linear least-squares fit indicated an improved period of $23^{d}.25 \pm 0^{d}.09$. We considered the possibility of incorrect cycle count between the different groups, but the addition or subtraction of one count produced values of $21^{d}.7 \pm 0^{d}.1$ and $24^{d}.8 \pm 0^{d}.1$, both inconsistent with the value $23^{d}.2 \pm 0^{d}.3$ determined earlier by analysis of the different groups separately.

A representative epoch of minimum light, taken near the midpoint of the last group, would be JD 2446030.0 ± $0^{d}.5$. Therefore we suggest using the ephemeris

$$\mathrm{JD} = \underset{\pm .5}{2,446,030.0} + \underset{\pm .09}{23^{d}.25}\, n \qquad (2)$$

to predict future times of minimum light for HR 9024.

To convince ourselves that the variable is HR 9024 and not the comparison star HD 223848, we analyzed the 125 differential measures Boyd had made between that comparison star and his check star HD 400. Sinusoidal fits phased to correspond to the last six θ_{min} values in Table I all gave amplitudes which were zero within their uncertainties.

It is interesting to note that, between 1982 and 1984, HR 9024 has doubled its amplitude from around $0^{m}.02$ to around $0^{m}.04$. It will be interesting to see what happens to this trend.

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