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PHOTOMETRIC VARIABILITY OF THE SPECTROSCOPIC BINARY HD 133822

The double-lined spectroscopic binary HD 133822 ($V = 7.7$, $P = 17\overset{d}{.}8$?) was investigated by Evans (1961) who derived spectral types of G5 IV and a set of orbital elements according to which eclipses were not excluded. Photometric variability is reported in the Seventh Catalogue of the orbital elements of spectroscopic binary systems (Batten et al., 1978). Were the system to be found eclipsing, it would be a most interesting late subgiant system with an eccentric orbit. At the suggestion of D.M. Popper and J. Andersen, we therefore included HD 133822 in our *uvby* observations with the Danish 50 cm telescope on La Silla, Chile, and obtained 87 observations in each colour on 28 nights during March-May 1984 (Table I). HR 5566 ($G\,3\text{-}5\,V$, $V = 6.35$) and HR 5699 ($G\,3\text{-}5\,V$, $V = 5.65$) were used as comparison stars.

Three unpublished CORAVEL observations from March 1984, kindly provided by J. Andersen, indicate slow rotation and confirm mass and luminosity ratios near one. When combined with Evans' data and assuming that his period is nearly correct, they lead to an improved spectroscopic ephemeris:

Min at HJD 243 6068.207 + $17\overset{d}{.}83792 \cdot E$

We found no indication of eclipses but we did find the system to be variable as indicated by the scatter given in Table II. We searched the interval from 17.7 to 18.2 days to see if any period here could describe the photometric variability, but with no success whatsoever. Visual inspection of a plot of the observations versus time showed a period near 7 days. Further period searches, covering the interval 6 to 8 days, revealed that only a period of 7.07 days (or possibly twice as large) fits the photometry. If we subtract cosine curves with this period and with amplitudes as given in Table II the residual scatter is near that expected from the photometry. Figure 1 shows the light curve in b and colour index curves for $(b\text{-}y)$ and c_1 with phases calculated from

HJD 244 5805.400 + $7\overset{d}{.}07 \cdot E$

Table I: Magnitude differences HD 133822 - HR 5566 in the instrumental system

HJD -2445000	u	v	b	y	HJD -2445000	u	v	b	y
784.65221	1.369	1.411	1.381	1.380	805.88398	1.363	1.409	1.382	1.378
.65739	1.371	1.417	1.388	1.387	.88626	1.362	1.412	1.380	1.382
.80836	1.365	1.414	1.386	1.380	807.64186	1.381	1.433	1.400	1.398
.81086	1.374	1.417	1.387	1.383	.64413	1.372	1.433	1.399	1.392
.88521	1.372	1.420	1.388	1.386	.74016	1.391	1.430	1.405	1.397
.88808	1.369	1.419	1.389	1.384	.74240	1.389	1.431	1.409	1.399
786.89100	1.395	1.441	1.411	1.404	.79553	1.380	1.431	1.402	1.396
.89362	1.401	1.441	1.410	1.401	.84714	1.397	1.433	1.406	1.403
787.86756	1.387	1.443	1.407	1.395	.84978	1.389	1.443	1.402	1.401
.87096	1.393	1.431	1.402	1.399	.89025	1.389	1.441	1.401	1.399
.88782	1.390	1.439	1.406	1.404	.89506	1.389	1.432	1.396	1.401
.89017	1.397	1.435	1.403	1.405	811.70062	1.368	1.419	1.389	1.388
788.69388	1.390	1.438	1.401	1.401	.70316	1.376	1.416	1.390	1.392
.69654	1.395	1.439	1.404	1.402	812.72032	1.369	1.406	1.382	1.377
.76857	1.386	1.432	1.399	1.401	.72291	1.372	1.413	1.384	1.384
.77103	1.390	1.439	1.401	1.400	813.83784	1.379	1.429	1.395	1.391
792.90256	1.384	1.421	1.395	1.388	.83988	1.385	1.422	1.391	1.391
.90480	1.388	1.429	1.393	1.393	814.75051	1.390	1.442	1.417	1.408
794.74611	1.406	1.446	1.408	1.408	.75298	1.386	1.439	1.404	1.402
.74854	1.402	1.441	1.407	1.406	815.75638	1.398	1.446	1.412	1.410
795.87532	1.398	1.437	1.406	1.401	.75938	1.403	1.449	1.414	1.410
.87753	1.386	1.435	1.403	1.397	.80181	1.397	1.445	1.411	1.409
797.83582	1.375	1.410	1.382	1.383	.80407	1.414	1.450	1.410	1.410
.83855	1.372	1.407	1.385	1.381	816.77490	1.403	1.450	1.413	1.406
798.58473	1.368	1.403	1.377	1.380	.77710	1.402	1.440	1.404	1.406
.58707	1.369	1.408	1.376	1.377	.85372	1.399	1.440	1.410	1.409
.62144	1.361	1.409	1.384	1.377	.85619	1.406	1.438	1.410	1.408
.62480	1.358	1.404	1.379	1.381	817.59730	1.391	1.427	1.401	1.394
.66323	1.359	1.406	1.378	1.376	.59962	1.384	1.432	1.399	1.394
.66553	1.361	1.411	1.376	1.378	.65992	1.386	1.421	1.400	1.397
.71901	1.362	1.409	1.373	1.379	.66233	1.389	1.430	1.394	1.397
.72119	1.365	1.407	1.378	1.374	818.72079	1.371	1.416	1.388	1.387
.76507	1.359	1.407	1.376	1.378	.72298	1.376	1.412	1.393	1.390
.76722	1.352	1.409	1.377	1.379	821.57493	1.396	1.441	1.398	1.396
.82225	1.363	1.399	1.379	1.378	.57716	1.393	1.432	1.398	1.397
.82538	1.362	1.407	1.382	1.376	822.61904	1.406	1.444	1.416	1.408
799.84860	1.376	1.422	1.401	1.390	.62099	1.404	1.453	1.411	1.409
.85087	1.373	1.425	1.398	1.390	826.74817	1.361	1.411	1.387	1.381
801.89213	1.408	1.443	1.411	1.407	.75057	1.369	1.406	1.383	1.385
.89440	1.406	1.448	1.411	1.405	830.64425	1.397	1.440	1.408	1.405
803.89312	1.383	1.421	1.391	1.393	.64735	1.406	1.445	1.410	1.407
.89556	1.384	1.425	1.400	1.391	831.74469	1.380	1.419	1.397	1.390
804.85754	1.352	1.415	1.374	1.379	.74701	1.375	1.421	1.394	1.390
.86005	1.370	1.412	1.384	1.389					

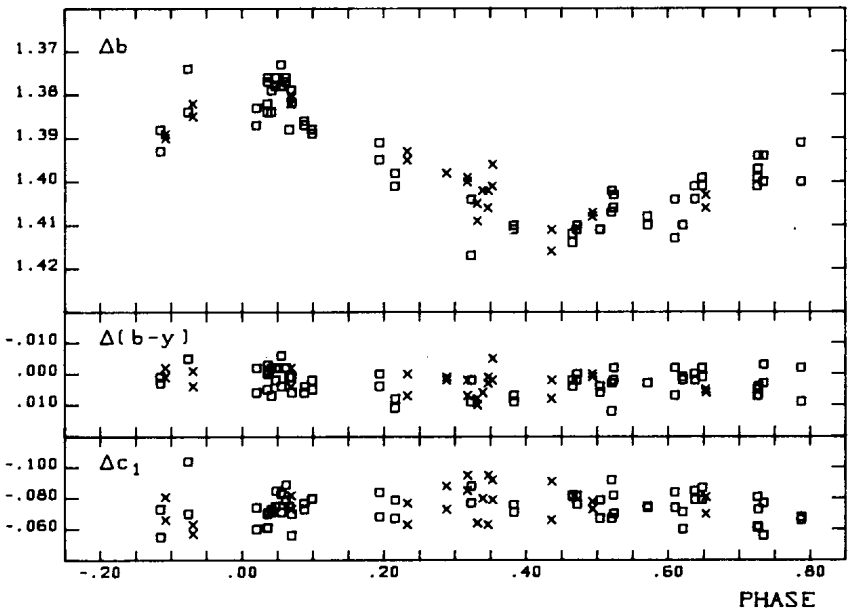

Figure 1. Light and colour curves of HD 133822, assuming a period of 7^d.07. If the period is doubled, observations plotted as crosses will lie in the phase interval from 0.0 to 0.5, squares from 0.5 to 1.0.

We derive the following average values for the Strömgren indices:

V = 7.742 $\quad$ b-y = 0.441

c_1 = 0.273 $\quad$ m_1 = 0.266

If we accept the spectroscopic result that the stars are indeed nearly identical all indices are compatible with the stars being main sequence stars of spectral type $G6$ - $G8$ while luminosity class IV is ruled out because of the low value of the c_1 index. We find M_v = 5.3, T_{eff} = 5500 K and [Fe/H] = -0.03. This is in agreement with a recent result of Lü and Tsay (1983) who find M_v = 5.4 and

Table II: Photometric variability of HD 133822

	scatter around mean value	amplitude of cosine curve	residual scatter after subtraction of cosine curve	mean errors from comparison star differences
y	0.011	0.013	0.004	0.002
b	0.012	0.015	0.004	0.003
v	0.014	0.018	0.005	0.003
u	0.015	0.018	0.006	0.005

spectral type G6 V. We suggest that the system consists of two normal main sequence stars of solar composition. For such a system eclipses would be very narrow, lasting less than 0.017 in phase (assuming Evans' period). In that case, we actually cannot completely exclude the possibility that the system is eclipsing, since the uncertainty in epoch is about 0.7 days.

Attempts have been made at fitting the spectroscopic observations to periods near 7 or 14 days, by applying changes of sign to whatever observations seemed to need it, but they have been unsuccessful. Considering the problems with component identification on the spectrograms which Evans reports, and noting the large scatter in his figure and the smooth run of the CORAVEL observations (obtained on consecutive nights), it is clear that a definitive ephemeris and radial velocity curve can be found from radial velocity spectrometer observations. Since few empirical mass and radius determinations for main sequence G stars exist, we urge observers with access to such an instrument to place the system on their observing list.

The question remains what is the cause of the photometric variability reported here. Two obvious possibilities are:

(1) One or both stars could be spotted and rotate (synchronously or non-synchronously) with a period of 7.07 days, which means an equatorial rotational velocity of about 6 km/s, large enough that spots are likely to develop.

(2) The variability could be related to an orbital period near 14.14 days. Note, however, that ellipsoidal deformation must be negligible, because the relative radii are on the average only about 0.03.

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