1979, *Astron. Astrophys. Suppl.* **36**, 283-285.

PERIOD AND SPECTROSCOPIC ORBIT OF TU HOR

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Received September 28, 1978

A spectroscopic orbit of the ellipsoidal binary system TU Hor is given. Some estimates concerning the inclination of the orbit and the nature of the secondary can be made. Both components seem to be main sequence stars.

Key words: ellipsoidal variable – spectroscopic orbit

1. INTRODUCTION

Recently it was found on the basis of *UBV* photometry that the bright star HR 1081 = TU Hor is an ellipsoidal binary with a period of 0.935984 days (Duerbeck 1977). The present paper gives the results of new spectroscopic and photometric observations.

2. OBSERVATIONS AND REDUCTIONS

32 spectrograms of TU Hor were obtained with the coudé spectrograph of the ESO 152 cm telescope. Four spectra have the dispersion 20 Å mm^{-1} (F-numbers), 28 have the dispersion 12 Å mm^{-1} (G-numbers, see table 1). The wavelength interval 3600 to 4900 Å was recorded on baked IIa–O emulsion. The spectrograms were measured with the oscilloscope-type Abbe comparator of the Hoher List observatory. Generally 12 lines (Hγ to H 15, Ca II 3933, Mg II 4481) could be measured. The results are given in table 1. Because of the small number of lines and the Stark broadening of the H lines, the mean internal error is ± 4.1 km s^{-1}.

Furthermore, simultaneous photoelectric observations were secured in three nights with the ESO 50 cm telescope. They cover only part of the light curve but a comparison with the 1976 results (Duerbeck 1977) shows that the asymmetry of the light curve has not changed in the course of a year.

Using the light elements of the earlier paper, the new observations are shifted slightly to later phases. The following improved ephemeris is obtained:

$$\text{J.D. hel. (Minimum I)} = \underset{\pm .001}{2443055.620} + \underset{\pm .000006}{0.935971} \cdot E$$

This ephemeris was used to calculate the phases in table 1.

3. THE RADIAL VELOCITY CURVE

The radial velocity observations are shown in figure 1. The scatter in the first half of the curve is much larger in the second half, while the observing conditions and the internal errors of the radial velocities are about the same. The larger scatter in the radial velocity curve coincides with the higher one of the two light maxima.

The somewhat incomplete coverage of observations does not permit a solution of an elliptical orbit, which is anyhow not likely to occur in a close binary system. The least squares solution yields:

$$\text{Radial velocity} = (\underset{\pm 1.1}{-28.1} \sin \varphi + \underset{\pm 0.9}{44.6}) \text{ km s}^{-1}.$$

The mass function is $f(M) = 0.00216 \pm 0.00008$.

4. DISCUSSION

The mass function yields possible configurations for all inclinations. The interval $i=0°$ to $i=10°$ can be excluded because the secondary would have a mass high enough to become visible in the spectrum. Likewise, inclinations higher than $i=37°$ are not likely to occur because the mass of the secondary would indicate a star of type M0 or later, which has hitherto not been observed in similar eclipsing binary systems. For the remaining interval the system is always a detached one.

Estimates of i can be made in the following ways:

a) If the primary is a synchroneously rotating main sequence star, $v \sin i$ yields $i=35°$ (Duerbeck 1977).
b) A typical "ellipticity" A_2 term of a short period EB system with i near 90° is of the order of -0.125 (e.g. DM Del, Schneller 1960; or TT Her, Hogg and Kron 1955). The observed A_2 term for TU Hor is -0.045, corresponding to $i=36°$, with an error that may be 10°.

With the mass function determined above, a close binary consisting of an A2 and a late K main sequence star with a mass of about 0.5 $M_{\odot}$ is able to produce the observed radial velocity variations when seen at an inclination of about 35°. The photometric behaviour, however, is more difficult to explain. The ellipticity term, A_2, is connected with the quantities q, r_g and i by the approximate relation

$$-A_2 \approx \frac{3\,(15+x)}{20\,(3-x)}(1+y)\, q\, r_g^3 \sin^2 i$$

(Kopal 1959, Eqs. 12–22 in Part VI). Inserting $x=0.5$, $y=0.8$, $q=0.2$, $r_g=0.45$, $i=35°$, A_2 turns out to be -0.010. The observed A_2 is -0.045 if one takes mean amplitudes, or -0.020 if one analyzes the lower maximum of the light curve only.

Analysis of the EB type system TX Cet where the Russell model was not applicable (Duerbeck and Ammann 1978) also yields an observed A_2 term which is about twice as large as calculated from the quantities q, r_g and i. Thus TU Hor may also be an EB type system (without eclipses) with strongly interacting components. Light curves with similar asymmetries have also been observed in eclipsing binary systems consisting of two main sequence stars (e.g. RT Scl, Cillié and Lindsay 1958; AG Vir, Binnendijk 1969). It may be interesting to study the long term variability of the light curve and the period of TU Hor.

ACKNOWLEDGEMENTS

We thank the referee for adding valuable comments to the discussion. Calculations were carried out with the CYBER 172 of the Max-Planck-Institut für Radioastronomie, Bonn.

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Table 1 Radial velocities

ESO-No.	J.D.hel. (2 443 000 +)	phase	R.V.
F 4946	061.654	0.4468	+39.9
F 4947	.673	0.4671	+35.6
F 4948	.683	0.4778	+43.0
F 4949	.703	0.4991	+49.2
G 8646	375.742	0.0213	+48.7
G 8627	.830	0.1153	+31.2
G 8629	.861	0.1484	+16.9
G 8631	.883	0.1719	+25.3
G 8633	.907	0.1976	+14.3
G 8634	.917	0.2083	+18.9
G 8635	.929	0.2211	+11.8
G 8644	376.770	0.1196	+15.6
G 8646	.815	0.1677	+20.8
G 8648	.853	0.2083	+ 7.1
G 8649	.869	0.2254	+22.2
G 8651	.895	0.2532	+12.0
G 8652	.913	0.2724	+24.4
G 8653	.931	0.2916	+20.1
G 9025	505.536	0.6944	+67.0
G 9026	.550	0.7093	+68.8
G 9028	.595	0.7574	+70.2
G 9029	.608	0.7713	+74.3
G 9031	.634	0.7991	+70.6
G 9033	.655	0.8215	+69.7
G 9035	.680	0.8482	+73.2
G 9036	.694	0.8632	+67.5
G 9039	506.528	0.7542	+70.2
G 9041	.568	0.7870	+67.7
G 9044	.605	0.8365	+73.6
G 9050	507.567	0.8643	+61.8
G 9053	.604	0.9039	+59.9
G 9056	.641	0.9434	+57.3

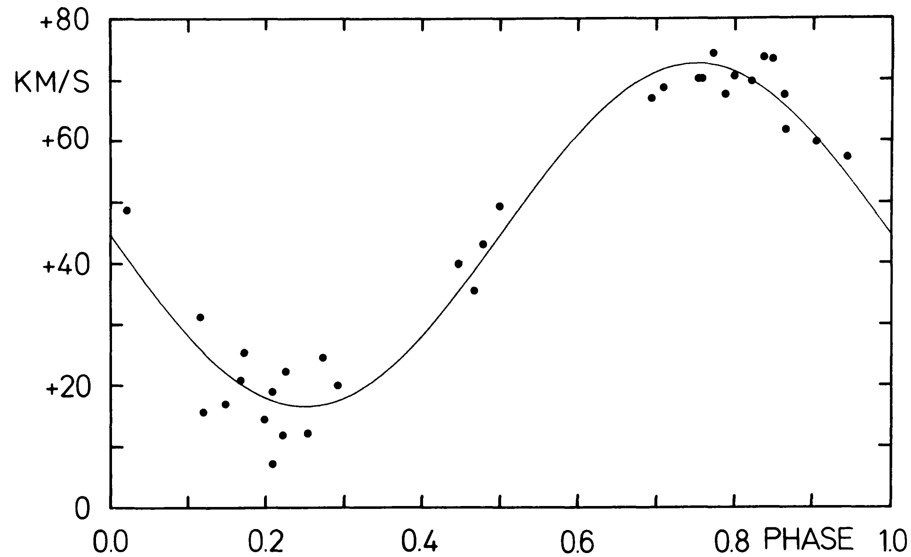

Figure 1 The radial velocity curve of TU Hor.