COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3606

Konkoly Observatory
Budapest
20 May 1991
HU ISSN 0374 - 0676

A FURTHER PROOF ON THE BINARY MODEL OF HD 94033

HD 94033 was discovered by Przybylski and Bessell (1979) as a dwarf Cepheid with a pulsation period of 86 min.

We have observed 23 times of light maximum with the 60cm reflector at Xinglong station of Beijing Observatory from 1981 to 1991. Additionally, we collected 67 times of light maximum from the literature (Hobart et al., 1985; McNamara, 1985; McNamara et al., 1985). Combined with the 90 data, we have done some analysis of the period and noticed that the O-C values exhibit regular variation with a long period of about 9 years. New data provided here enable the periodicity to be repeated twice, and the analysis indicates that the growth rate of pulsation period is bigger than that in the literature (Yang Xiabing et al., 1985).

Table I gives the heliocentric epochs of maximum of HD 94033. Column 2 is the cycle number of each maximum, column 3 and 4 are the residual values computed with the parabolic equation and the binary model respectively.

After a least squares fit for all the times of maximum by following equation,

$$T_{max} = T_0 + P_0 E + 0.5\beta E^2$$

and substracting this parabola, we get Figure 1 showing how O-Cs vary with cycle number E. It is very clear that the new observation supports the hypothesis of binary model suggested by Jiang Shiyang (1986).

According to the light travel time effect in binary model, we use another (as following) formula to fit the times of maximum again.

$$T_{max} = T_0 + P_0 E + 0.5\beta E^2 + A\sin\varphi + B\cos\varphi + C$$

where $\varphi = 2\pi f(T - \tau) + e\sin\varphi$

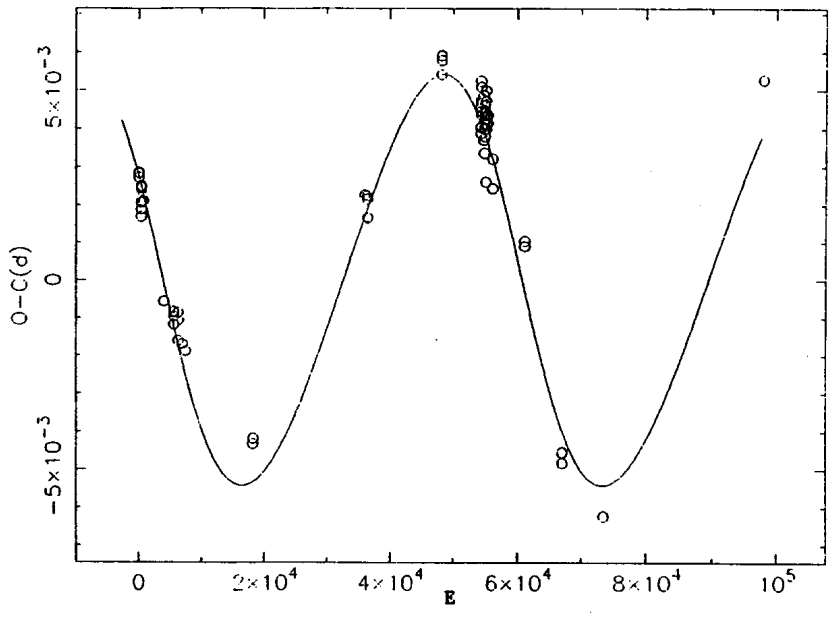
$$A = \frac{a \sin i}{c}\sqrt{1 - e^2}\cos\omega$$

$$B = \frac{a \sin i}{c}\sin\omega$$

Table 1. Times of light maximum for HD94033

T_{max} HJD2440000.+	E	$(O-C)_p$ day	(O-C) day	T_{max} HJD2440000.+	E	$(O-C)_p$ day	(O-C) day
2516.1585	0	0.0027	-0.0001	5751.7243	54369	0.0044	0.0003
2517.9439	30	0.0029	0.0000	5769.7564	54672	0.0046	0.0005
2518.0034	31	0.0028	0.0001	5769.8158	54673	0.0045	0.0006
2518.1223	33	0.0027	0.0001	5769.8750	54674	0.0041	0.0002
2541.9266	433	0.0025	0.0000	5770.6479	54687	0.0034	-0.0005
2541.9859	434	0.0024	-0.0002	5770.7077	54688	0.0037	-0.0005
2542.0448	435	0.0017	-0.0009	5770.7674	54689	0.0039	0.0001
2542.1044	436	0.0019	-0.0006	5776.7185	54789	0.0038	-0.0003
2542.8787	449	0.0025	-0.0000	5777.6699	54805	0.0031	-0.0008
2542.9382	450	0.0025	0.0000	5777.7303	54806	0.0039	0.0002
2542.9973	451	0.0021	-0.0004	5782.6699	54889	0.0041	0.0003
2543.8903	466	0.0024	0.0000	5782.7294	54890	0.0041	0.0003
2544.0094	468	0.0025	-0.0001	5782.7890	54891	0.0042	0.0004
2545.9137	500	0.0025	0.0001	5782.8485	54892	0.0042	0.0004
2545.9729	501	0.0021	-0.0003	5783.6812	54906	0.0037	-0.0002
2562.9930	787	0.0021	-0.0003	5783.7410	54907	0.0040	0.0003
2755.2111	4017	-0.0006	-0.0006	5783.8000	54908	0.0035	-0.0006
2846.9767	5559	-0.0010	0.0003	5784.6935	54923	0.0043	0.0003
2847.0958	5561	-0.0009	0.0005	5784.7527	54924	0.0040	0.0004
2847.1550	5562	-0.0012	0.0000	5784.8125	54925	0.0043	0.0004
2890.0628	6283	-0.0009	0.0008	5792.6660	55057	0.0023	-0.0014
2890.9553	6298	-0.0011	0.0007	5793.2037	55066	0.0044	0.0005
2891.9664	6315	-0.0016	0.0000	5793.2629	55067	0.0041	0.0001
2929.9939	6954	-0.0017	0.0004	5793.6792	55074	0.0038	0.0000
2958.9161	7440	-0.0019	0.0005	5795.0488	55097	0.0047	0.0009
3601.6931	18241	-0.0044	0.0009	5795.1073	55098	0.0037	-0.0000
3604.6688	18291	-0.0043	0.0009	5795.1670	55099	0.0038	0.0000
4664.2720	36096	0.0021	0.0004	5795.6431	55107	0.0038	0.0000
4690.0997	36530	0.0019	-0.0001	5796.0606	55114	0.0047	0.0009
4690.1593	36531	0.0020	-0.0000	5796.1194	55115	0.0040	0.0005
4691.1109	36547	0.0014	-0.0006	5796.1793	55116	0.0044	0.0006
4691.1705	36548	0.0015	-0.0005	5798.6785	55158	0.0041	0.0006
5383.2904	48178	0.0051	-0.0001	5800.6422	55191	0.0040	0.0001
5384.1834	48193	0.0055	0.0003	5808.6168	55325	0.0041	0.0003
5384.2430	48194	0.0056	0.0003	5808.6761	55326	0.0038	0.0004
5748.7479	54319	0.0036	-0.0004	5808.7358	56327	0.0040	0.0004
5748.8081	54320	0.0043	0.0001	5854.4989	56096	0.0029	-0.0002
5748.8671	54321	0.0038	-0.0003	5856.4620	56129	0.0021	-0.0012
5748.9278	54322	0.0049	0.0007	6153.0652	61113	0.0006	0.0006
5748.9861	54323	0.0037	-0.0002	6153.1248	61114	0.0007	0.0012
5749.7608	54336	0.0048	0.0006	6501.2014	66963	-0.0049	-0.0012
5749.8199	54337	0.0044	0.0002	6503.1650	66996	-0.0052	-0.0012
5749.8795	54338	0.0045	0.0002	6503.2248	66997	-0.0049	-0.0011
5749.9387	54339	0.0041	-0.0002	6889.1548	73482	-0.0067	-0.0013
5750.9503	54356	0.0041	-0.0002	8348.1510	97998	0.0047	0.0012

Figure 1 The O - C Diagram



$$C = -\frac{a \sin i}{c} e \sin \omega$$

where $\varphi, f, \tau, e, c, a \sin i, \omega$ are the eccentric anomaly, orbital frequency, time of periastron passage, eccentricity, velocity of light, projected semimajor axis and longitude of the periastron passage in the plane of the orbit respectively.

The least squares fit yields the following pulsational and orbital elements of HD 94033.

$T_0 = \text{H.J.D}2442516.15576 \pm 0.0003$

$P_0 = 0.059511036 \pm 0.00000017$ day

$\beta = (2.92 \pm 0.18) \times 10^{-12}$

$f = 0.0002956 \pm 0.0000036$ /day;

or: $P_b = 33829.5 \pm 41.2$ day

$a \sin i = (1.43 \pm 0.17) \times 10^8$ km $= 0.95 \pm 0.11$ A.U.

$e = 0.2$

$\tau = \text{H.J.D.}2442708.4$

$\omega = 175°$

The solid line constructed in Figure 1 was determined by the above 8 factors.

Here, we would like to make some explanation. From Figure 1 we can see that e is relatively small, and it is difficult to determine ω, τ exactly with fewer data, we can only regard the above 3 values as reference.

The further proof about binary model on HD 94033 needs more photometry, and a better method is to obtain spectral information.

LIU YANYING, JIANG SHIYANG

Beijing Astronomical Observatory
Chinese Academy of Sciences

CAO MING

Shanxi Astronomical Observatory
Chinese Academy of Sciences

References:

Hobart, M.A. et al.: 1985, Rev. Mex. Astron. Astrofis., 11, 19.
Jiang Shiyang: 1986, Ke Xue Tong Bao, 21, 1642.
McNamara, D.H.: 1985, P.A.S.P., 97, 715.
McNamara, D.H. et al.: 1985, P.A.S.P., 97, 322.
Przybylski, A., Bessell, M.S.: 1979, M.N.R.A.S., 189, 377.
Yang Xiabing et al.: 1985, Acta Astrophysica Sinica, 5, 192.