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HAS THE DELTA SCUTI STAR AD CMi A COMPANION?

AD CMi is a δ Scuti type variable with an amplitude of 0.30 magnitude and stable light curve. Jiang (1987) and Rodríguez et al. (1988) published many observations and suggested an increasing period change. Rodríguez et al. (1990) and Yang et al. (1992) reported some new times of light maxima, with the linear and quadratic solutions.

To check how the star's period varies with time, the authors observed AD CMi again in three nights, from 15 to 17 February, 1994, in Yunnan Astronomical Observatory. The telescope used is a 1 meter reflector with a conventional single-channel photoelectric photometer plus a Johnson V filter. From the new observational data, three new maximum times of AD CMi were determined. Table 1 lists all the times of light maxima collected from the literature and derived from our new observations. For all the data, the linear fit is used to determine the calculated times of light maxima, $T_{max} = T_{01} + P_{01} \times E$. The results of fitting are: T_{01} = HJD 2436601.8210, $P_{01} = 0.12297449$ $days$. And the $(O-C)_l$ are listed in table 1. Then a parabolic curve is used to fit the data as: $T_{max} = T_{02} + P_{02} \times E + 0.5\beta \times E^2$. Thus, we got the fitting parameters as: T_{02} = HJD 2436601.8223 $days$, $P_{02} = 0.12297433$ $days$, $\beta = 1.7 \times 10^{-12}$ $days/cycle$. Figure 1 shows the $O-C$ diagram and the fit curve using the parabolic function.

Because many groups of data point distribute above or below the fit curve in Figure 1, which seems to suggest that there is a trigonometric function type variation, we tried to use the following formula to fit the individual maxima, $T_{max} = T_{03} + P_{03} \times E + 0.5\beta \times E^2 + A \sin\varphi + B \cos\varphi$. The last two terms correspond to possible light-time effect caused by the orbital motion, whereas φ is the solution of the equation: $\varphi - e \sin\varphi = 2\pi f(P_{03} \times E - \tau)$, in which e is the eccentricity of the elliptical orbit; f, the orbital frequency; τ , the time of periastron. Figure 2 shows the derived $O-C$ residuals and the fit curve using both the parabolic and the trigonometric function. The related parameters thus obtained are as below:

T_{03}(HJD)	P_{03}(days)	β(day/cycle)	A(days)	B(days)	f(day^{-1})	e	res(days)
2436601.8203	0.12297446	4.6×10^{-13}	0.0010	0.0026	0.0000912	0.5898	2.6×10^{-3}

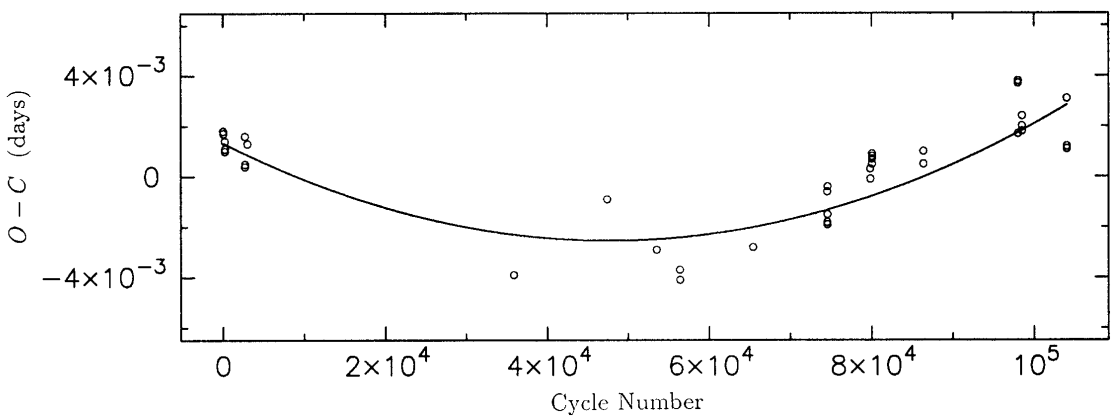

Figure 1. The O−C diagram and the fit curve using the parabolic function

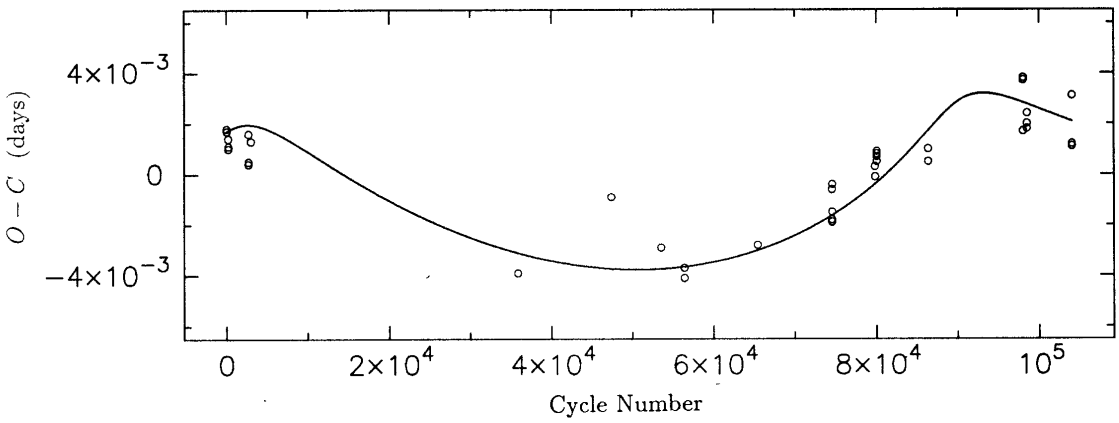

Figure 2. The O−C diagram and the fit curve using the parabolic function and the trigonometric function

Based on the fit above, the authors tend to think that the model of explaining the discrepancies between the observed and calculated times of maximum light as the consequence of a continuously changing (increasing) period, combined with the light-time effect caused by the orbital motion of AD CMi around the mass center of a binary system with an unseen companion, is reasonable. The orbital period here obtained is about 30.0 years. The rate of the period change, β, is now in agreement with the forecast of the stellar evolution theory, both in the direction of the period changes (increase) and the value of the rate of change ($\sim 0.46 \times 10^{-12}$ day/cycle). However, we should mention that due to the limitation of the number of data points, the solution provided here corresponds to that with the smallest residual among many possible solutions with different parameter values. It is necessary to obtain more observations, especially radial velocity information, to check our new model and determine the parameters in the end.

Table 1. Times of light maxima of AD CMi

i	E_i	T_i	$(O-C)_l$	W	Ref	i	E_i	T_i	$(O-C)_l$	W	Ref
1	0	36601.8228	0.0018	1.0	Ab	24	74574	45772.5187	−0.0019	1.0	R8
2	8	36602.8066	0.0018	1.0	Ab	25	79818	46417.3991	0.0003	0.5	Ji
3	9	36602.9296	0.0018	1.0	Ab	26	79825	46418.2596	−0.0001	2.0	Ji
4	25	36604.8971	0.0017	1.0	Ab	27	79826	46418.3825	−0.0001	2.0	Ji
5	211	36627.7700	0.0014	1.0	Ab	28	79833	46419.2434	−0.0001	2.0	Ji
6	219	36628.7538	0.0014	1.0	Ab	29	79834	46419.3663	−0.0001	2.0	Ji
7	227	36629.7373	0.0011	1.0	Ab	30	80027	46443.1010	0.0005	1.0	Ji
8	228	36629.8602	0.0010	1.0	Ab	31	80028	46443.2243	0.0008	2.0	Ji
9	2683	36931.7620	0.0004	1.0	An	32	80029	46443.3470	0.0005	2.0	Ji
10	2691	36932.7470	0.0016	1.0	An	33	80035	46444.0850	0.0007	1.0	Ji
11	2708	36934.8364	0.0005	1.0	An	34	80036	46444.2082	0.0009	2.0	Ji
12	2992	36969.7620	0.0013	1.0	An	35	80037	46444.3312	0.0009	2.0	Ji
13	35852	41010.6985	−0.0039	0.5	La	36	86340	47219.4395	0.0010	2.0	R9
14	47389	42429.4582	−0.0009	0.1	Ep	37	86340	47220.4228	0.0005	2.0	R9
15	53512	43182.4290	−0.0029	2.0	Ba	38	97999	48653.2017	0.0037	1.0	Ya
16	56390	43536.3488	−0.0037	2.0	Ba	39	98023	48656.1511	0.0017	2.0	Ya
17	56391	43536.4714	−0.0041	2.0	Ba	40	98024	48656.2762	0.0038	2.0	Ya
18	65406	44645.0877	−0.0028	2.0	Ji	41	98486	48713.0884	0.0018	1.0	Ya
19	74524	45766.3713	−0.0006	1.0	R8	42	98494	48714.0724	0.0020	1.0	Ya
20	74540	45768.3377	−0.0018	1.0	R8	43	98518	48717.0242	0.0024	1.0	Ya
21	74541	45768.4606	−0.0019	1.0	R8	44	104065	49399.1625	0.0012	2.0	pp
22	74565	45771.4134	−0.0004	1.0	R8	45	104073	49400.1462	0.0011	2.0	pp
23	74573	45772.3961	−0.0015	1.0	R8	46	104081	49401.1320	0.0031	1.0	pp

*Ab Abhyankar, K.D., 1959, *Ap.J.*, **130**, 834

*An Anderson, L.R., McNamara, D.H., 1961, *Publ. Astr. Soc. Pacific*, **94**, 289

*La Langford, W.R., 1976, Ph. Thesis, Brigham Young University

*Ep Epstein, I., Epstein, A.E.A., 1973, *A.J.*, **78**, 83

*Ba Balona, L.A., Stobie, R.S., 1983, *South African Astron. Obs.*, **7**, 19

*Ji Jiang, S.Y., 1987, *Chin. Astron. Astrophys.*, **11**, 343

*R8 Rodríguez, E., Rolland, A., López de Coca, P., 1988, *Rev. Mex. Astron. Astrofis.*, **16**, 7

*R9 Rodríguez, E., Rolland, A., López de Coca, P., 1990, *IBVS*, No.3427

*Ya Yang, D.W., Tang, Q.Q., and Jiang, S.Y., 1992, *IBVS*, No. 3770

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References:

Jiang, S.Y., 1987, *Chin. Astron. Astrophys.*, **11**, 343
Rodríguez, E., Rolland, A., López de Coca, P., 1988, *Rev. Mex. Astron. Astrofis.*, **16**, 7
Rodríguez, E., Rolland, A., López de Coca, P., 1990, *IBVS*, No. 3427
Yang, D.W., Tang, Q.Q., and Jiang S.Y., 1992, *IBVS*, No. 3770