Rev. Mexicana Astron. Astrof., **22**, 235-242 (1991)

PHOTOELECTRIC OBSERVATIONS OF W UMA STARS: U PEGASI AND AB ANDROMEDAE

L. Maupomé[1,†], E. Rodríguez[1,4], M.A. Hobart[2,3]
J.H. Peña[1,2], and R. Peniche[1,2]

Received 1991 February 11

RESUMEN

Se reportan observaciones fotoeléctricas recientes de los sistemas tipo W UMa, U Pegasi y AB Andromedae. De los tiempos de mínimos encontrados en la literatura junto con los obtenidos en las presentes observaciones se determinan las efemérides cuadráticas siguientes:

Para U Peg: HJD_{min} = 2436511.6706 (± 0.0035) + 0.3747818 (± 1.27 × 10^{-7}) E − 1.08 × 10^{-10} (± 0.0324 × 10^{-10}) (E^2/2) y para AB And: HJD_{min} = 2440128.7945 (± 0.0035) + 0.33189162 (± 9 × 10^{-8}) E + 8.74 × 10^{-11} (± 0.16 × 10^{-11}) (E^2/2); denotando un cambio continuo en sus periodos de −0.91 s/siglo para U Peg y 0.83 s/siglo para AB And.

ABSTRACT

Recent photoelectric-photometric data of the W UMa systems U Pegasi and AB Andromedae are reported. From the times of minima found in the literature and those obtained in the present paper, the following quadratic ephemerides were calculated:

For U Peg: HJD_{min} = 2436511.6706 (± 0.0035) + 0.3747818 ± 1.27 × 10^{-7}) E − 1.08 × 10^{-10} (± 0.0324 × 10^{-10}) (E^2/2) and for AB And: HJD_{min} = 2440128.7945 (± 0.0035) + 0.33189162 (± 9 × 10^{-8}) E + 8.74 × 10^{-11} (± 0.16 × 10^{-11}) (E^2/2); implying a continuous change in the period of −0.91 s/century for U Peg and 0.83 s/century for AB And.

Key words: **STARS-W URSAE MAJORIS – STARS-VARIABLE – STARS-ECLIPSING BINARIES**

I. INTRODUCTION

Because of their high abundance in space and their very conspicuous light curves, the W UMa stars are very important in the field of stellar evolution. They form the group which has aroused the most controversy among the close binary systems. Many models have been developed to explain the light curves of these stars which very often show instabilities. In addition, since this class of stars can be observed with rather modest telescopes, the amount of observational data available makes possible reliable determinations of their period behavior. Also, many of these stars show variations in their periods which are explained with several hypotheses, namely, through apsidal motion, interaction with a third component of the system, changes in their separation, changes in the mass of the system or the interchange of mass among the components. To establish the mechanism that produces the changing period, continuous observations are needed (Wood 1950). With this idea in mind, it was decided to reobserve two W UMa type stars: U Pegasi and AB Andromedae. In this paper, new photoelectric observations of these two systems are presented and an analysis of their period behavior has been made.

U Pegasi, which was discovered by Chandler in 1894 (Chandler 1895), is a well studied system. The history of its observations can be found in Lafta and Grainger 1986, where a very complete compilation of the times of minima is also presented. These data together with the minima obtained from the photometry in this paper (Tables 2 and 3) were used to analyze the period variation of this system.

AB Andromedae has been studied since its

1. Instituto de Astronomía, UNAM.
2. Instituto Nacional de Astrofísica, Optica y Electrónica.
3. Facultad de Física, Universidad Veracruzana.
4. Instituto de Astrofísica de Andalucía.
† deceased June 26 1991.

TABLE 1

COORDINATES AND MAGNITUDES OF THE OBSERVED STARS

Star	BD	α (1900)	δ	V (mag)	Type
U Pegasi	+15°4915	$23^h52^m52^s$	+15°23'48"	10.0	W UMa
C_1	+15 4916	23 53 46	+15 17 14	8.8	Ref.
C_2	+14 5077	23 52 09	+15 04 13	7.9	Ref.
AB Andromedae	+36 5017	23 06 46	+36 21 06	10.5	W UMa
C_1	+36 5020	23 06 54	+36 14 54	8.0	Ref.
C_2	+36 5021	23 07 38	+36 25 43	6.9	Ref.

discovery in 1927 by Guthnick and Prager (1927). A summary of the past observations can be found in Rovithis and Rovithis (1981). It has been reported that this star has shown asymmetries in its light curve (Bell, Hilditch and King 1984). From the times of minima found in the literature and those recently obtained by the authors of this paper, (Tables 4 and 5), an analysis of the variation of the period of this close binary was made.

II. OBSERVATIONS

Most of the observations took place at the Observatorio Astronómico Nacional at San Pedro Mártir with the 84-cm reflecting telescope. The same equipment was used every night, namely, a dry-ice cooled RCA 31034A photocell with a pulse counting system and Johnson's V filter. The following observing method was adopted for both stars: two comparison stars were chosen for each program star according to the usual criteria that they must be of approximately the same magnitude as the variable star and that they be within two degrees of it. The characteristics of the program stars and their corresponding comparisons are shown in Table 1.

U Pegasi was observed during the nights of November 2-3 and 3-4, 1989, while the observations of AB Andromedae were carried out during the nights of October 27-28, 28-29, November 1-2 and 4-5, 1989. The photoelectric data obtained are shown in Table 2 for U Peg and Table 4 for AB And. The light curves of U Peg for the observed nights are shown in Figure 1. The light curves of AB And for each night are shown in Figure 3. In all cases each observation consisted of 30 s integrations on each star. The sequence of observations followed was C, C, V, C, C, V, etc., with a 10 s integration of the sky each 40 minutes. The photometric values plotted are the instrumental magnitude differences between the variable star and one of the comparison stars, which for convenience will be designated by C_1 in Table 1, interpolated at the time of the observation of the variable. An average of the differences was then subtracted from each run to establish the zero baseline. The data points are accurate to $0^m\!.005$; the average time interval between successive points is $0^d\!.005$ while the accuracy in time for each point is $0^d\!.0007$.

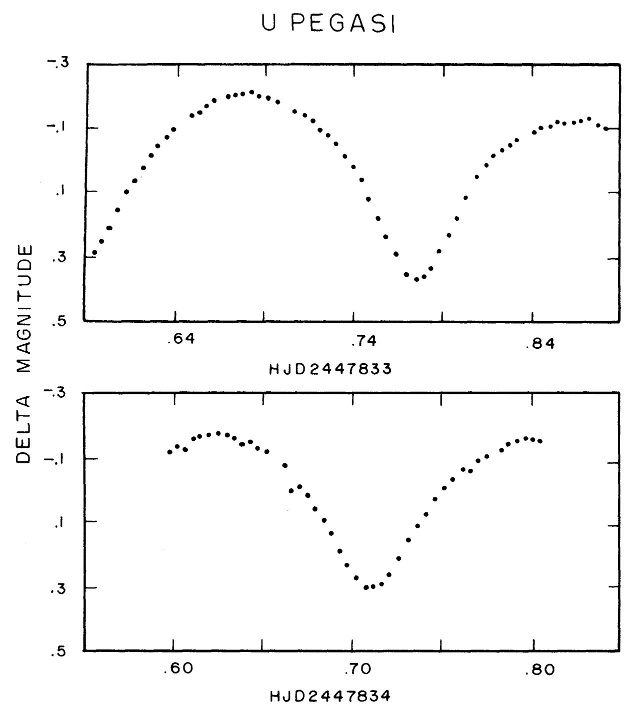

Fig. 1. a) and b) Light curves of the observed nights of U Peg.

In addition *ubvy*-β data for both stars were obtained on the night of November 8, 1989 with the

TABLE 2

PHOTOELECTRIC OBSERVATIONS OF U PEGASI

HJD 2440000+	ΔMAG	HJD 2440000+	ΔMAG	HJD 2440000+	ΔMAG
7833.596	0.284	7833.770	0.353	7834.639	−0.131
7833.599	0.249	7833.775	0.365	7834.643	−0.134
7833.603	0.204	7833.780	0.357	7834.648	−0.117
7833.608	0.153	7833.784	0.333	7834.652	−0.106
7833.613	0.098	7833.789	0.281	7834.662	−0.066
7833.617	0.062	7833.793	0.229	7834.666	0.015
7833.622	0.021	7833.798	0.176	7834.671	−0.001
7833.626	−0.016	7833.803	0.117	7834.675	0.030
7833.630	−0.049	7833.809	0.053	7834.680	0.066
7833.635	−0.074	7833.814	0.013	7834.685	0.105
7833.639	−0.101	7833.818	−0.013	7834.689	0.147
7833.649	−0.142	7833.823	−0.032	7834.694	0.202
7833.653	−0.150	7833.828	−0.050	7834.699	0.248
7833.657	−0.172	7833.832	−0.065	7834.703	0.287
7833.662	−0.189	7833.841	−0.089	7834.708	0.313
7833.668	−0.204	7833.845	−0.102	7834.712	0.313
7833.673	−0.206	7833.850	−0.109	7834.717	0.304
7833.678	−0.207	7833.854	−0.121	7834.721	0.273
7833.682	−0.213	7833.858	−0.118	7834.727	0.224
7833.687	−0.203	7833.863	−0.121	7834.732	0.165
7833.692	−0.194	7833.867	−0.130	7834.737	0.122
7833.698	−0.183	7833.872	−0.131	7834.742	0.086
7833.707	−0.157	7833.877	−0.115	7834.747	0.039
7833.712	−0.141	7833.882	−0.103	7834.752	0.007
7833.717	−0.121	.....	....	7834.757	−0.022
7833.721	−0.100	....	....	7834.762	−0.057
7833.726	−0.079	7834.598	−0.107	7834.767	−0.051
7833.730	−0.053	7834.602	−0.120	7834.771	−0.078
7833.735	−0.014	7834.607	−0.110	7834.776	−0.092
7833.740	0.019	7834.611	−0.144	7834.784	−0.112
7833.744	0.062	7834.616	−0.153	7834.789	−0.129
7833.748	0.122	7834.621	−0.158	7834.793	−0.139
7833.754	0.183	7834.625	−0.163	7834.798	−0.150
7833.758	0.241	7834.630	−0.158	7834.802	−0.143
7833.764	0.292	7834.634	−0.148	7834.807	−0.138

1.5-m telescope of the Observatorio Astronómico Nacional using with a *uvby-β* photometer that allows the simultaneous obtention of data in each filter. The method used in the data acquisition and reduction has been reported earlier (see for example, Peniche *et al.* 1990). The uncertainties for the photometric values obtained from the standard stars of all the season have an accuracy of $\delta(V, b-y, m_1, c_1, H\beta)$ of (0.012, 0.007, 0.011, 0.011, 0.009). The photometric values derived are presented in Table 6.

III. ANALYSIS

In order to determine the period accurately, a long time span of observations is required to provide a sufficiently large amount of times of minimum light. In many stars there are some indications in the O−C residuals of a secular period variation if a constant period is assumed. (See for example, Figures 2a and 4a of the present paper). In these cases, it can be assumed that the period is not constant. Hence, the following expression must be used,

$$P = P_0 + \alpha E \qquad (1)$$

where P_0 is the period at a given epoch, E, and α is the rate at which the period is changing, (which also includes the case of a constant period when $\alpha = 0$).

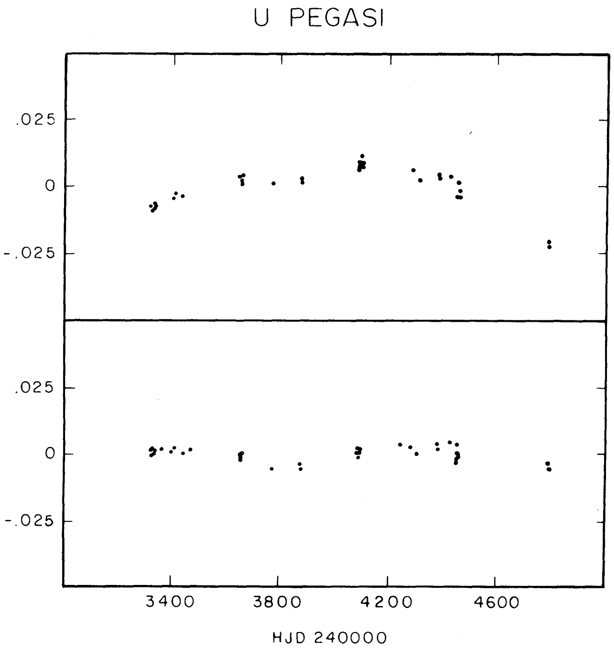

Fig. 2. a) O–C residuals versus HJD for U Peg from the linear ephemeris HJD = 2436511.6663 + 0.3747809 E derived in this paper. b) O–C residuals versus HJD for the quadratic ephemeris HJD = 2436511.6706 + 0.3747818 E − 1.08 × 10^{-10} $E^2/2$ derived in this paper.

If

$$P = dT/dE \qquad (2)$$

then

$$dT = (P_0 + \alpha\, E)dE \qquad (3)$$

so, integration

$$T = T_0 + P_0\, E + (\alpha/2)\, E^2 \quad . \qquad (4)$$

This equation gives the general expression of the ephemeris if a regular period variation (1) is assumed. From these relations, if a fixed uncertainty in the determination of the times of minimum light is assumed (typically dT = $0^d_.0035$), the accuracy of P and α can be estimated from the time coverage of the observations or from the number of cycles covered in such a time interval.

a) *U Pegasi*

For U Pegasi, assuming a period of $0^d_.37478094$, the number of cycles covered in the time span of the observations (Table 3) is E = 39094 which gives for the accuracy in the period 1.27 × 10^{-7} d and for the accuracy in the quadratic coefficient 3.24 × 10^{-12} d. The times of minima , covering a time span of 40 years, were used to analyze the period behavior of U Pegasi. These times of minima are shown in Table 3. As a first step the residuals O–C were calculated from the linear ephemeris (α = 0)

$$HJD_{min} = 2436511.6663\ (\pm 0.0035) + \\ + 0.3747809\ (\pm 1.27 \times 10^{-7})\ E$$

which was determined through the use of a computer program that has already been described by Hobart *et al.* 1989. The residuals from this ephemeris are shown in the third column of Table 3 under the heading $(O–C)_L$. The standard deviation of these residuals is equal to $0^d_.0071$. The plot of

TABLE 3

TIMES OF MINIMA AND O–C RESIDUALS OF U PEGASI FOR LINEAR AND QUADRATIC FITS

HJD	Min.	$(O–C)_L$	$(O–C)_Q$	Ref.
2433182.8561	I	−0.00624	0.00170	1
2433190.7262	I	−0.00654	0.00136	1
2433190.9132	II	−0.00693	0.00097	1
2433202.7181	I	−0.00763	0.00022	1
2433230.6408	II	−0.00611	0.00160	1
2433244.5075	II	−0.00630	0.00134	1
2433255.5630	I	−0.00684	0.00075	1
2433558.7624	I	−0.00518	0.00095	1
2433924.5497	I	−0.00404	0.00043	2
2433998.9448	II	−0.00295	0.00120	3
2434303.4545	I	−0.00273	0.00014	2
2434685.3586	I	−0.00037	0.00099	2
2436481.6864	I	0.00257	−0.00165	4
2436483.7490	II	0.00387	−0.00035	4
2436484.6839	I	0.00182	−0.00241	4
2436508.6702	I	0.00214	−0.00214	4
2436511.6688	I	0.00250	−0.00180	4
2436515.6057	II	0.00420	−0.00010	4
2437636.0099	I	0.00090	−0.00561	5
2438689.7081	II	0.00259	−0.00510	6
2438691.7693	I	0.00250	−0.00520	6
2438692.7072	II	0.00345	−0.00425	6
2440826.9010	I	0.00741	−0.00008	5
2440827.8396	II	0.00906	0.00156	5
2440831.7729	I	0.00716	−0.00033	5
2440832.7122	II	0.00951	0.00201	5
2440837.7692	I	0.00697	−0.00052	5
2440888.7399	I	0.00746	0.00002	5
2440891.7381	I	0.00742	−0.00002	5
2440892.6793	II	0.01166	0.00422	5
2440893.8008	II	0.00882	0.00138	5
2442347.3879	I	0.00820	0.00298	7
2442741.2810	I	0.00658	0.00224	7
2443021.6134	I	0.00286	−0.00077	8
2443785.0431	I	0.00387	0.00244	9
2443785.2312	II	0.00458	0.00315	9
2443789.3530	II	0.00379	0.00237	10
2444185.3093	I	0.00407	0.00398	11

TABLE 3 (CONTINUED)

HJD	Min.	$(O-C)_L$	$(O-C)_Q$	Ref.
2444469.3857	I	−0.00344	−0.00251	12
2444490.3786	I	0.00171	0.00273	12
2444500.4922	I	−0.00376	−0.00271	13
2444501.4295	II	−0.00341	−0.00236	13
2444502.5554	II	−0.00185	−0.00079	13
2444503.4923	I	−0.00191	−0.00084	13
2444504.6165	I	−0.00205	−0.00098	13
2447833.7754	I	−0.02188	−0.00409	14
2447834.7121	II	−0.02188	−0.00409	14

σ_L = 0.00706 (Linear fit)
σ_Q = 0.00243 (Quadratic fit)

1) LaFara (1952); 2) Kwee (1958); 3) Huruhata *et al.* (1957); 4) Binnendijk (1960); 5) Rigterink (1972); 6) Gordon (1975); 7) Patkos (1976); 8) Mallama *et al.* (1977); 9) Zhai *et al.* (1984); 10) Pohl and Glmen (1981); 11) Patkos (1980); 12) Aslan *et al.* (1981); 13) Rovithis and Rovithis (1982); 14) Present paper.

such residuals versus HJD is shown in Figure 2a, which clearly shows that the period of this system is decreasing. From the form of this graph, it is seen that the quadratic term in equation (5) is necessary to describe better the times of minima. This quadratic term implies, according to equation (1), a continuous variation of the period.

A quadratic least squares fit gives

$$HJD_{min} = 2436511.6706\ (\pm 0.0035) + 0.3747818\ (\pm 1.27 \times 10^{-7})\ E - 1.08 \times 10^{-10}\ (\pm 0.0324 \times 10^{-10})\ E^2/2.$$

The residuals obtained from this quadratic ephemeris are shown in the fourth column of Table 3 under the heading $(O-C)_Q$. The corresponding plot of residuals versus HJD is shown in Figure 2b. The description of the times of minima given by the quadratic ephemeris is seen to be better. The standard deviation calculated for these quadratic residuals is $0\overset{d}{.}0024$, numerically smaller than the standard deviation obtained for the linear analysis.

b) *AB Andromedae*

This star was analyzed in the same way. The times of minimum light are shown in the first column of Table 5. The accuracy in the period and in the quadratic coefficient were calculated to be 9×10^{-8} d and 1.63×10^{-12} d respectively corresponding to a time span of 50.17 years or 55175 cycles. The residuals for the linear ephemeris

$$HJD_{min} = 2440128.7945\ (\pm 0.0035) + 0.33189114\ (\pm 9 \times 10^{-8})\ E$$

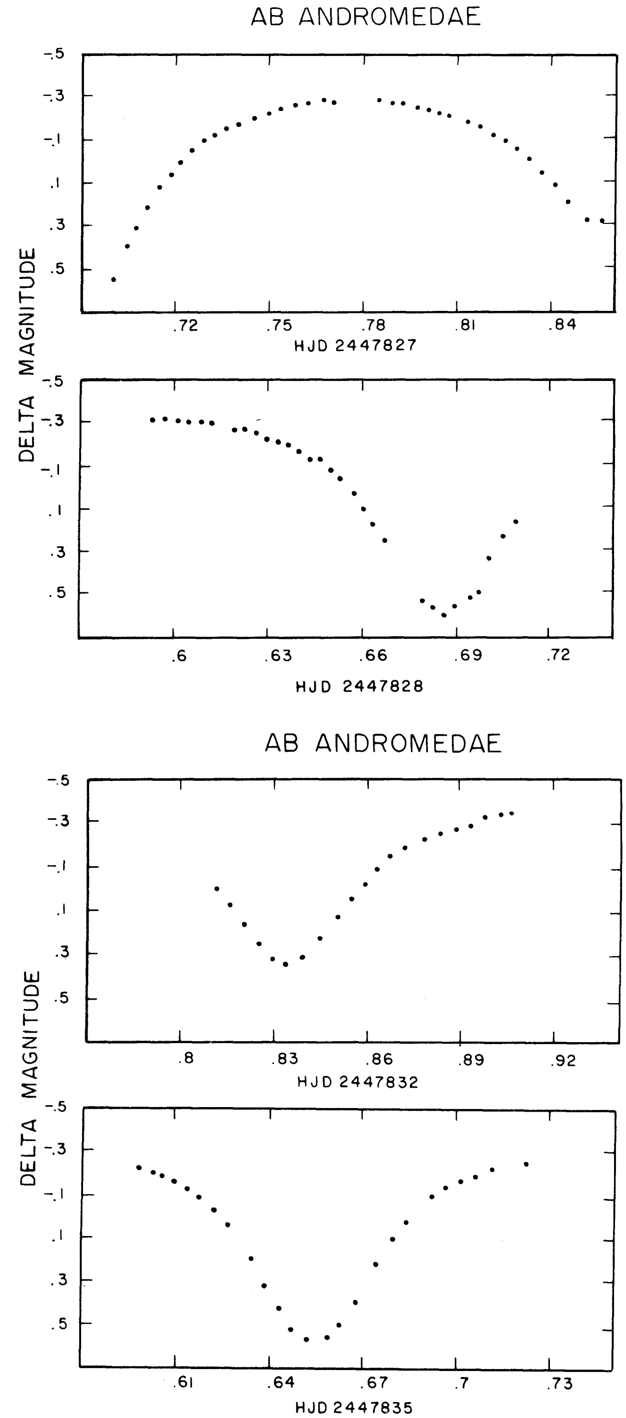

Fig. 3. a), b), c), and d) Light curves of the observed nights of AB And.

are shown in the third column of Table 5 under the heading $(O-C)_L$. A standard deviation of $0\overset{d}{.}013$ is calculated. The plot of these residuals versus HJD (Figure 4a) shows that the period is

TABLE 4

PHOTOELECTRIC OBSERVATIONS OF AB ANDROMEDAE

HJD 2440000+	ΔMAG	HJD 2440000+	ΔMAG	HJD 2440000+	ΔMAG
7827.700	0.548	7828.601	−0.310	7832.862	−0.083
7827.705	0.397	7828.604	−0.306	7832.866	−0.138
7827.707	0.308	7828.608	−0.302	7832.871	−0.180
7827.711	0.219	7828.612	−0.295	7832.877	−0.221
7827.715	0.124	7828.619	−0.268	7832.882	−0.246
7827.719	0.061	7828.622	−0.270	7832.887	−0.268
7827.721	0.005	7828.626	−0.256	7832.892	−0.280
7827.726	−0.046	7828.629	−0.222	7832.897	−0.315
7827.729	−0.089	7828.632	−0.214	7832.902	−0.333
7827.732	−0.116	7828.636	−0.194	7832.905	−0.338
7827.737	−0.149	7828.639	−0.171	....	....
7827.740	−0.171	7828.643	−0.129	....	....
7827.746	−0.199	7828.646	−0.124	7835.598	−0.224
7827.750	−0.217	7828.650	−0.076	7835.602	−0.202
7827.753	−0.236	7828.653	−0.034	7835.605	−0.188
7827.758	−0.261	7828.657	0.036	7835.609	−0.159
7827.762	−0.267	7828.660	0.109	7835.613	−0.128
7827.767	−0.281	7828.664	0.179	7835.618	−0.088
7827.771	−0.277	7828.667	0.258	7835.622	−0.032
7827.785	−0.280	7828.679	0.532	7835.627	0.036
7827.789	−0.270	7828.682	0.567	7835.634	0.190
7827.793	−0.260	7828.686	0.601	7835.638	0.309
7827.797	−0.243	7828.689	0.557	7835.643	0.420
7827.801	−0.231	7828.694	0.514	7835.647	0.514
7827.804	−0.216	7828.697	0.494	7835.652	0.563
7827.807	−0.203	7828.700	0.330	7835.659	0.552
7827.813	−0.174	7828.705	0.228	7835.663	0.498
7827.817	−0.152	7828.709	0.162	7835.668	0.387
7827.821	−0.120	....	....	7835.674	0.210
7827.825	−0.089	....	....	7835.679	0.101
7827.829	−0.048	7832.811	0.004	7835.684	0.019
7827.832	−0.004	7832.816	0.087	7835.692	−0.095
7827.837	0.056	7832.820	0.166	7835.696	−0.139
7827.841	0.114	7832.825	0.253	7835.701	−0.169
7827.845	0.189	7832.829	0.326	7835.706	−0.191
7827.851	0.276	7832.834	0.347	7835.711	−0.222
7827.856	0.284	7832.839	0.315	7835.722	−0.253
....	....	7832.844	0.227	....	....
....	....	7832.850	0.134	....	....
7828.593	−0.312	7832.854	0.053	....	....
7828.596	−0.315	7832.858	−0.013	....	....

smoothly increasing and that a quadratic term in the ephemeris would give a better fit to the residuals than a linear one. The quadratic ephemeris is found to be

$$\mathrm{HJD}_{min} = 2440128.7945\ (\pm 0.0035) + $$
$$+\ 0.33189162\ (\pm 9 \times 10^{-8})\ \mathrm{E}\ +$$
$$+\ 8.74 \times 10^{-11}\ (\pm 0.16 \times 10^{-11})\ \mathrm{E}^2/2.$$

The O–C residuals for this ephemeris are shown in the fourth column of Table 5 under the heading $(\mathrm{O{-}C})_Q$ and are plotted versus HJD in Figure 4b. It can be seen that this quadratic ephemeris gives a better description than the linear one. The standard deviation of these residuals is $\sigma_\alpha = 0.008$ which is less than the corresponding value for the linear ephemeris.

TABLE 5

AB ANDROMEDAE
TIMES OF MINIMA AND O-C RESIDUALS
FOR LINEAR AND QUADRATIC FITS

HJD	Min.	$(O\text{–}C)_L$	$(O\text{–}C)_Q$	Ref.
2429523.5830	I	0.03812	0.00886	1
2429550.6312	II	0.03719	0.00812	2
2429907.7398	II	0.03092	0.00428	2
2430257.8803	II	0.02626	0.00191	2
2430611.8379	I	0.02195	−0.00019	2
2430962.6450	I	0.02012	0.00006	1
2431046.6150	I	0.02166	0.00209	1
2431350.4580	II	0.01831	0.00046	2
2431707.9018	II	0.01535	−0.00058	2
2432133.0469	II	0.00790	−0.00588	2
2432413.1603	II	0.00517	−0.00727	2
2432793.6710	I	0.00267	−0.00804	1
2433207.3684	II	−0.00224	−0.01121	2
2433886.5780	I	−0.00786	−0.01428	3
2434264.6000	I	−0.00988	−0.01502	4
2435075.4070	I	−0.01294	−0.01575	5
2435370.4600	I	−0.01117	−0.01326	6
2435782.3360	I	−0.01208	−0.01328	7
2436069.4210	I	−0.01292	−0.01357	8
2436109.5784	I	−0.01440	−0.01498	9
2436124.6801	II	−0.01371	−0.01427	9
2436132.6461	II	−0.01309	−0.01364	9
2440128.7945	I	0.00000	0.00000	10
2440129.7901	I	−0.00009	−0.00010	10
2440131.7816	I	0.00003	0.00003	10
2440158.6648	I	0.00007	0.00002	10
2440158.8313	II	0.00060	0.00056	10
2440828.7568	I	0.00388	0.00267	11
2440828.9226	II	0.00373	0.00252	11
2440829.7525	I	0.00390	0.00269	11
2440829.9181	II	0.00356	0.00235	11
2440883.6855	II	0.00459	0.00327	11
2440883.8511	I	0.00425	0.00293	11
2440885.6769	II	0.00465	0.00332	11
2440885.8427	I	0.00450	0.00318	11
2440886.6728	II	0.00487	0.00355	11
2440886.8382	I	0.00433	0.00300	11
2444136.3931	I	0.01304	0.00086	12
2444136.5579	II	0.01189	−0.00029	12
2444137.3871	I	0.01136	−0.00082	12
2444137.5525	II	0.01082	−0.00137	12
2444138.5486	II	0.01124	−0.00095	12
2444912.0257	II	0.01603	0.00002	13
2444912.8597	I	0.02031	0.00429	13
2444913.8542	I	0.01913	0.00311	13
2445260.8456	II	0.01834	0.00045	13
2445261.0098	I	0.01660	−0.00129	13
2445262.8367	II	0.01809	0.00020	13
2445263.0015	I	0.01695	−0.00095	13
2447828.6893	I	0.02026	−0.01442	14
2447832.8336	II	0.01592	−0.01879	14
2447835.6538	I	0.01505	−0.01969	14

TABLE 5 (CONTINUED)

$\sigma = 0$ .01297 (Linear fit)
$\sigma = 0$ .00752 (Quadratic fit)

1) Woodward 1951; 2) Oosterhoff 1950; 3) Domke and Pohl 1952; 4) Ashbrook 1952, 1953; 5) Szafraniec 1955; 6) Szafraniec 1956; 7) Szafraniec 1957; 8) Satanova and Grigorevsky 1957; 9) Binnendijk 1959; 10) Landolt 1969; 11) Rigterink 1973. 12) Rovithis-Livaniou and Rovithis 1981; 13) Bell, Hilditch and King 1984; 14) Present paper.

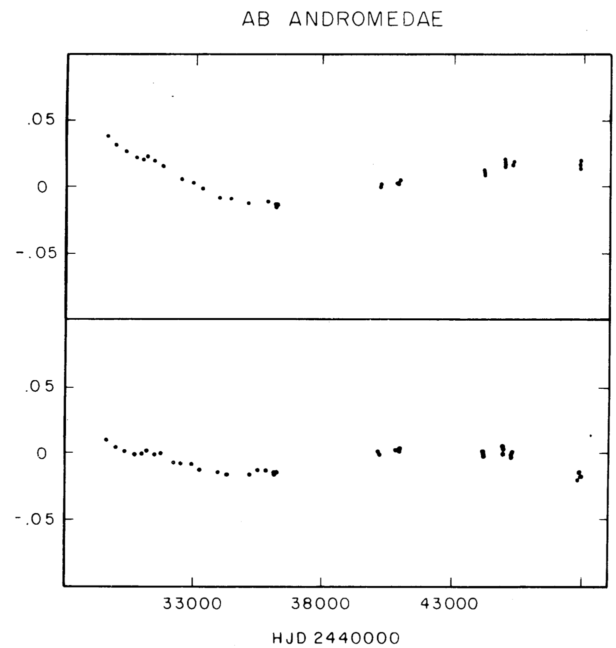

Fig. 4. a) O–C residuals versus HJD for AB And from the linear ephemeris HJD = 2440128.7945 + 0.33189114 E derived in this paper. b) O-C residuals versus HJD from the quadratic ephemeris HJD = 2440128.7945 + 0.33189162 E + 8.74 × 10^{-11} $E^2/2$ derived in the present paper.

IV. DISCUSSION

From the analysis of the period behavior carried out in this paper, one can safely conclude that U Pegasi has a smoothly decreasing period with a rate of change of −0.91 s/century, while the period of AB Andromedae is continuously increasing at the rate of 0.83 s/century. The O–C residuals of this quadratic fit suggest a sinusoidal variation that, in general, is explained by the presence of a third unseen object. More observations are encouraged

TABLE 6

uvby-Hβ PHOTOELECTRIC OBSERVATIONS OF U PEG AND AB AND

Star	V	$b-y$	m_1	c_1	Hβ	HJD 2447838+	Phase
AB And	....	....	....	....	2.558	0.6922	0.0554
AB And	9.570	0.546	0.340	0.278	....	0.6926	0.0558
AB And	....	....	....	....	2.579	0.7370	0.1002
AB And	....	....	....	....	2.563	0.7387	0.1019
AB And	9.566	0.542	0.340	0.289	....	0.7388	0.1020
AB And	....	....	....	....	2.582	0.7395	0.1027
U Peg	....	....	....	....	2.620	0.7485	0.0476
U Peg	....	....	....	....	2.587	0.7498	0.0489
U Peg	....	....	....	....	2.589	0.7517	0.0508
U Peg	....	....	....	....	2.584	0.7528	0.0519
U Peg	....	....	....	....	2.578	0.7546	0.0537
U Peg	9.488	0.398	0.184	0.347	....	0.7548	0.0539
U Peg	....	....	....	....	2.603	0.7555	0.0546
U Peg	....	....	....	....	2.604	0.7573	0.0564
U Peg	....	....	....	....	2.598	0.7593	0.0584

in order to increase the time span for U Peg and AB And and so to obtain more accurate values for the rate of change of their periods.

Special recognition is given to the staff of the San Pedro Mártir Observatory. Drawings were made by T. Gómez, proofreading by J. Miller. We are grateful to Conacyt for the travel support of E.R. and grant P228CCDX880202.

REFERENCES

Ashbrook, J. 1952, *A.J.*, **57**, 259.
Ashbrook, J. 1953, *A.J.*, **58**, 171.
Aslan, Z., Asir, A., Engins, S., Tufekcioglu, Z., and Yilmaz, N. 1981, *Inf. Bull. Var. Stars*, No. 1908.
Bell, S.A., Hilditch, R.W. and King, D.J. 1984, *M.N.R.A.S.*, **208**, 123.
Binnendjik, L. 1959, *A.J.*, **64**, 65.
Binnendjik, L. 1960, *A.J.*, **65**, 88.
Chandler, S.C. 1895, *A.J.*, **15**, 181.
Domke, K. and Pohl, E. 1952, *Astr. Nachr.*, **281**, 113.
Gordon, K.C. 1975, *Inf. Bull. Var. Stars*, No. 1010.
Guthnick, P. and Prager, R. 1927, *Astr. Nachr.*, **229**, 455.
Hobart, M.A., Peña, J.H., Gómez, T., and Alcalá, J.M. 1989, *Rev. Mexicana Astron. Astrof.*, **17**, 97.
Huruhata, M., Nikamura, T., and Kitamura, M. 1957, *Ann. Tokyo*, 2nd Ser. 5, 3.
Kwee, K.K. 1958, *Bull. Astron. I. Netherlands*, **14**, 131.
LaFara, R. 1952, *Ap. J.*, **115**, 14.
Lafta, S.J. and Grainger, J.F. 1986, *Ap. and Space Sci.*, **121**, 61.
Landolt, A.U. 1969, *A.J.*, **74**, 1078.
Mallama, A.D., Skillman, D.R., Pinto P.A., and Krobusek, B.A. 1977, *Inf. Bull. Var. Stars*, No. 1249.
Oosterhoff, P.T. 1950, *Bull. Astr. Inst. Netherlands*, **11**, 217.
Patkos, L. 1976, *Inf. Bull. Var. Stars*, No. 1200.
Patkos, L. 1980, *Inf. Bull. Var. Stars, No. 1751.*
Peniche, R., Peña, J.H., Díaz-Martínez, S.H., and Gómez, T. 1990, *Rev. Mexicana Astron. Astrof.*, **20**, 127.
Pohl, E. and Glmen, O. 1981, *Inf. Bull. Var. Stars*, No. 1924.
Rigterink, P.V. 1972, *A.J.*, **77**, 319.
Rigterink, P.V. 1973, *Astr. and Ap. Suppl.*, **12**, 313.
Rovithis-Livaniou, H. and Rovithis, P. 1981, *Ap. and Space Sci.*, **76**, 465.
Rovithis, P. and Rovithis Livaniou, H. 1982, *Ap. and Space Sci.*, **87**, 287.
Satanova, E.A. and Grigorevsky, V.M. 1957, *Astr. Circ. U.S.S.R.*, **187**, 17.
Szafraniec, R. 1955, *Acta Astr.*, **5**, 193.
Szafraniec, R. 1956, *Acta Astr.*, **6**, 141.
Szafraniec, R. 1957, *Acta Astr.*, **7**, 188.
Wood, F.B. 1950, *Ap. J.*, **112**, No.1, 196.
Woodward, E.J. 1951, *A.J.*, **56**, 77.
Zhai, D., Leung, K., and Zhang, R. 1984, *Astr. and Ap. Suppl.*, **57**, 487.

M.A. Hobart: Facultad de Física, Universidad Veracruzana, Apartado Postal 270, Jalapa, Ver., México.
L. Maupomé: Instituto de Astronomía, UNAM, Apartado Postal 70-264, 04510 México, D.F., México.
R. Peniche and J.H. Peña: Instituto de Astronomía, UNAM, Apartado Postal 70-264, 04510 México, D.F., México, and Instituto Nacional de Astrofísica, Optica y Electrónica, Apartados Postales 51 and 216, 72000 Puebla, Pue., México.
E. Rodríguez: Instituto de Astrofísica de Andalucía, Apdo. Correos 2144, E-18080 Granada, Spain.