GEOS
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GEOS CIRCULAR ON ECLIPSING BINARIES

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REVISED EPHEMERIS FOR THE ECLIPSING BINARY PP LAC

ABSTRACT : *PP Lac is a variable discovered by W.J. Miller; it was at first classified as "EW or RR ?", but later Figer and Rolland, by visual observations made by GEOS, found it to be an EW-type eclipsing binary and gave the first ephemeris.*
In this paper, 128 minima observed visually by GEOS members from 1976 to 1988,, plus 18 minima observed by BBSAG, are analysed. On the basis of these data, a more precise ephemeris can be computed :

$$Min\ I\ (or\ II) = JD_{Hel}\ 2442903{,}235 \pm 2 + 0{,}401\ 161\ 50 \pm 48\ .\ E \qquad (1)$$

It has been impossible to discriminate the primary minimum from the secondary one.

RESUME : *PP Lac est une étoile variable découverte par W.J. Miller et d'abord classifiée comme "EW ou RR ?". En 1977, des observations visuelles effectuées par le GEOS, permirent à A. Figer et R. Rolland de conclure qu'il s'agissait d'une binaire à éclipses du type EW et de donner une première éphéméride.*
Dans cet article, on analyse 128 minimums observés visuellement par le GEOS de 1976 à 1988 et 18 minimums observés par le BBSAG. Ces observations permettent de calculer une éphéméride plus précise :

$$Min\ I\ (ou\ II) = JJ_{Hel}\ 2\ 442\ 903{,}235 \pm 2 + 0{,}401\ 161\ 50 \pm 48\ .\ E$$

Il n'a pas été possible de différencier le minimum principal du minimum secondaire.

RIASSUNTO : *La variabile PP Lac fu scoperta da W.J. Miller, ed inizialmente classificata come "EW o RR ?". Successivamente, Figer e Rolland, tramite osservazioni GEOS, stabilirono trattarsi di una binaria ad eclisse di tipo EW e ne fornirono la prima effemeride. In questo articolo sono analizzati 128 minimi osservati visualmente da membri del GEOS tra il 1976 ed il 1988, unitamente a 18 minimi pubblicati dalla BBSAG. Sulla base di questi dati e' stato possibile calcolare la seguente effemeride :*

$$Min\ I\ (o\ II) = JD_{Hel}\ 2\ 442\ 903{,}235 + 2 + 0{,}401\ 161\ 50 + 48\ .\ E$$

Non e' risultato possibile distinguere il minimo principale da quello secondario.

RESUMEN : *PP Lac es una estrella variable descubierta por W.J. Miller y clasificada en principio como "EW o RR ?". En 1977, las observaciones visuales efectuadas por el GEOS, permitieron a A. Figer y R. Rolland concluir que se trataba de una bineria a eclipses del tipo EW y dar una primera efeméride. En este artículo, se analizan 128 mínimos observados visualmente por los miembros del GEOS de 1976 a 1988 y 18 mínimos observados por el BBSAG. Estas observaciones permiten calcular una efeméride más precisa :*

$$Min\ I\ (o\ II) = DJ_{Hel}\ 2\ 442\ 903{,}235 \pm 2 + 0{,}401\ 161\ 50 \pm 48\ E$$

No ha sido posible distinguir el mínimo principal del mínimo secundario.

Revised ephemeris for the eclipsing binary PP Lac

Introduction

PP Lac was discovered by W. J. Miller on photographic plates taken at Castel Gandolfo during 1948 - 1955 in the Cygnus star cloud.

Miller and Wachmann [1] found a range from 11.1 to 12.0 p and a period of about 0.5^{d}; the classification proposed was EW or RR.

The star was added to GEOS observing programme in 1976. Figer and Rolland [2],[3] classified the star as EW, finding a period of 0.4011^{d}. The classification was made on the basis of the shape of light curve, but it was impossible to discriminate between the primary and the secondary minima. Thus, an uncertainty still remains about the classification of the star.

The most recent edition of GCVS [4] gives the following elements:

EW/KW, 11.1 - 12.0 p; min II 12.0

$\text{Min I} = JD_{Hel}\ 2445595.438 + 0.401163 \cdot E$

In this paper, all visual observations made by GEOS will be analyzed (including those which led to the papers of Figer and Rolland [2],[3]), in order to obtain a more precise ephemeris, assuming that the star is an EW-type variable.

Observations

Visual observations were carried on by GEOS members until 1988. Most of observations were made using Argelander's method.

Fig. 1 shows the field of the variable and the comparison stars used. The magnitudes of the comparison stars had been roughly estimated by Figer and Rolland [3]. As the aim of this paper is to find a new ephemeris, and not to analyze the range of variation, the lack of precision in the values of magnitude of comparison stars does not represent a problem.

7 JUN. 1990

The light curves obtained by each observer during each night of monitoring were examined in order to find times of minimum of the variable. Some of these light curves are shown in figg. 2÷5. Minima were determined by the tracing-paper method.

A total of 128 minima, from 17 observers, was collected. Table 1 shows all observers (identified by a three-letter abbreviation) and the number of observed minima.

Table 1

Observer	*Site*	*abbr.*	*n. of minima*
A. Figer	Paris	FGR	68
A. Maraziti	Catanzaro	MRZ	20
Ph. Ralincourt	Nantes	RAL	12
P. Wils	Niel	WLS	11
R. Boninsegna	Dourbes	BNN	2
M. Penna	Asti	MPN	2
C. Romoli	Altopascio	RML	2
P. Baruffetti	Massa	BFF	1
G. Boistel	Nantes	BTL	1
J.F. Le Borgne	Toulouse	FLB	1
S. Ferrand	Bougival	FND	1
A. Grycan	Toulouse	GRY	1
P. Guiraudou	Montpellier	GUI	1
E. Le Saout		LSA	1
L. Maurin	Paris	MRN	1
C. Pampaloni	Firenze	PMP	1
L. Rivas	Valencia	RVS	1

In addition to these minima, 18 more minima published by BBSAG [5] have been analyzed. A linear regression on these 146 minima leads to the following ephemeris:

$$\text{Min I (or II)} = JD_{Hel}\ 2442903.235_{\pm 2} + 0.40116150_{\pm 48} \cdot E \qquad (1)$$

(95% level of confidence for error bars)

The ephemeris refers to primary or secondary minimum because, once more, it was impossible to discriminate between them (as we will see later).

Table 2 lists all minima, showing the O-Cs with respect to

this ephemeris. Residuals are comparable with intrinsic accuracy of visual observations; it results $\sigma_{o-c} = 0.010^d$, which is a typical value for a short period variable observed visually. Only one minimum lies beyond $\pm 3\sigma$, which is a further confirm of reliability of visual observations.

In order to check the ephemeris (1), the composite light curves obtained by the two more productive observers are shown in figg. 6,7. Each dot represents the moving average over an interval of 0.04 period; each interval is shifted by 0.02 period with respect to the previous one. The reason of using moving averages is to filter observing errors without affecting the general shape of the curve.

The shape of these curves is consistent with the hypothesis of an EW-type variable. Both curves show a difference between the two minima, but these differences are too small to be considered significant. The phases of minima are very close to 0.00 and 0.05, which confirms the validity of ephemeris (1).

Conclusion

A revised ephemeris for PP Lac has been calculated, assuming the EW classification for the star. This conjecture will be checked in a following paper, by means of photoelectric observations planned by GEOS members at Jungfraujoch Observatory.

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Bibliography

[1] Miller, W.J., Wachmann, A.A., 1971, Ricerche Astronomiche, vol.8, n.12.
[2] Figer, A., Rolland, R., 1977, I.B.V.S. no. 1231.
[3] Figer, A., Rolland, R., 1976, GEOS NC 142.
[4] Kholopov, P.N. et alii, 1985, Genetal Catalogue of Variable Stars.
[5] Locher, K., 1977, 1978, 1979, BBSAG Bulletin no. 32, 33, 35, 38, 40, 42, 44, 45.

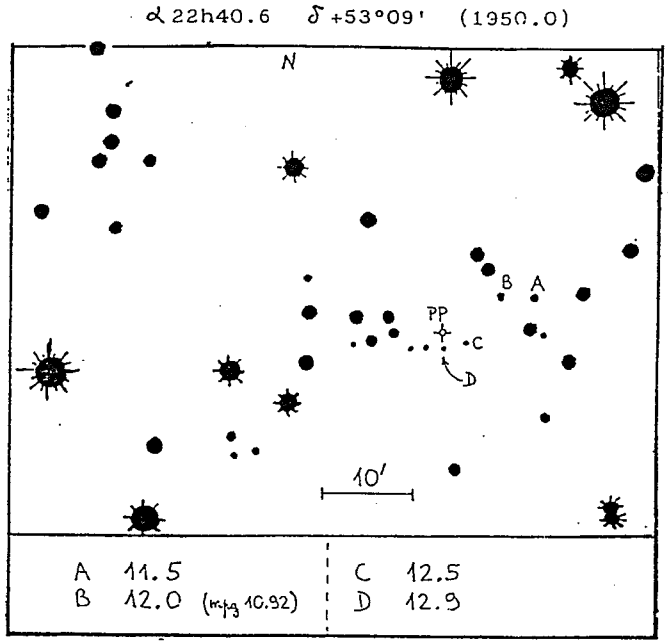
α 22h40.6 δ +53°09' (1950.0)
N
B
A
PP
C
D
10'
A 11.5
B 12.0 (mpg 10.92)
C 12.5
D 12.9

fig. 1

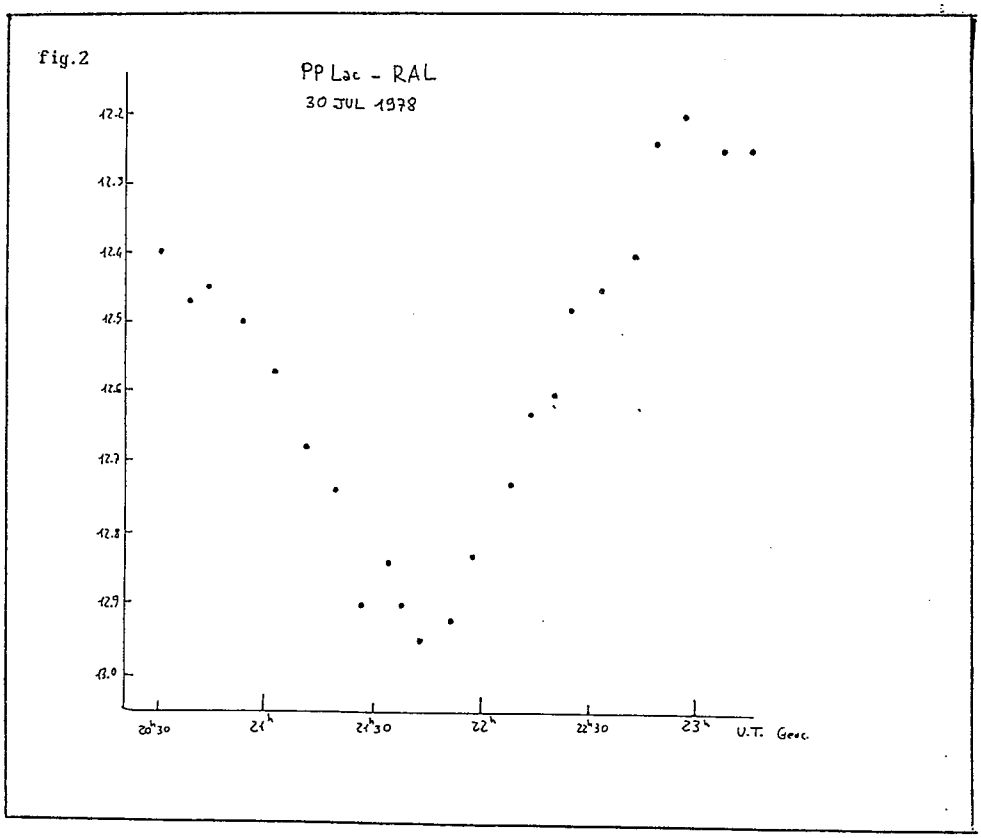
fig.2
PP Lac - RAL
30 JUL 1978
12.2
12.3
12.4
12.5
12.6
12.7
12.8
12.9
13.0
20h30
21h
21h30
22h
22h30
23h
U.T. Geoc.

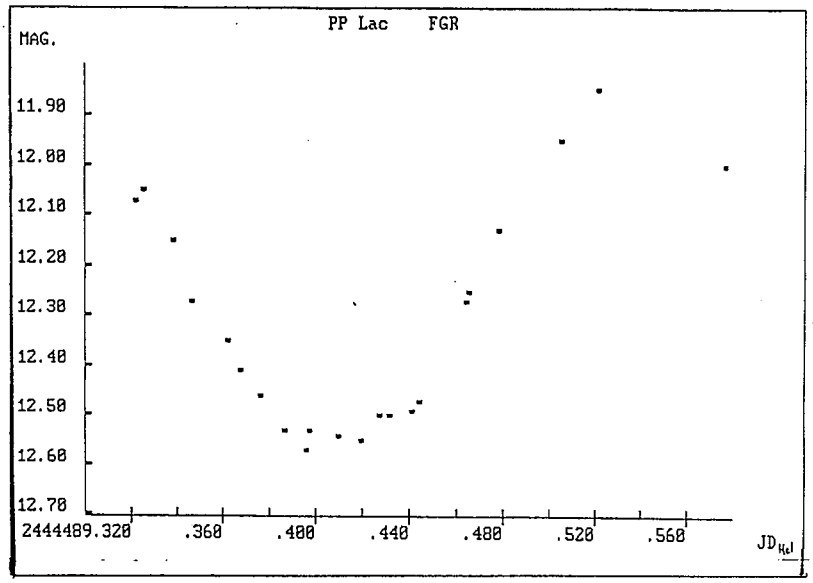

fig.3

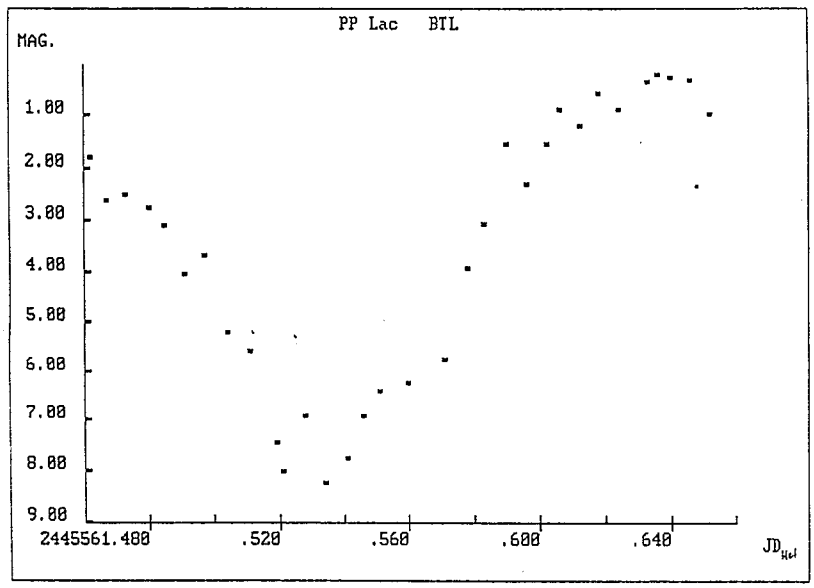

fig.4

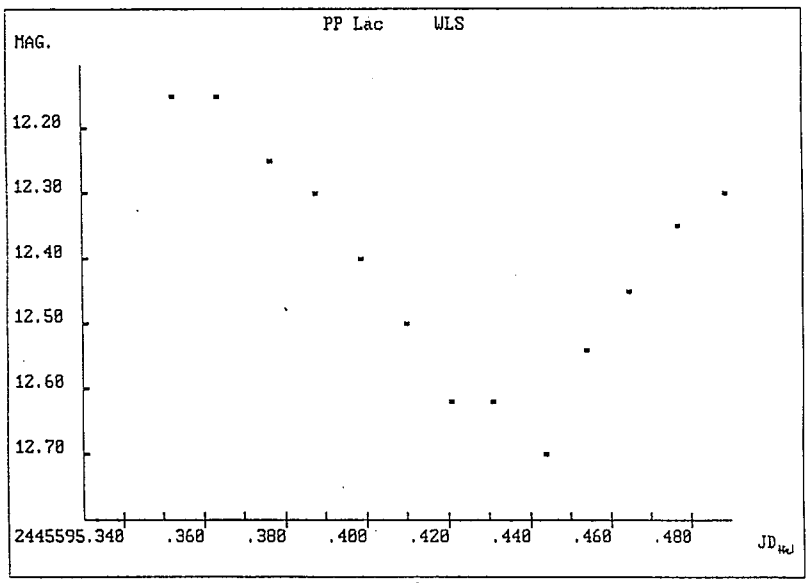

fig.5

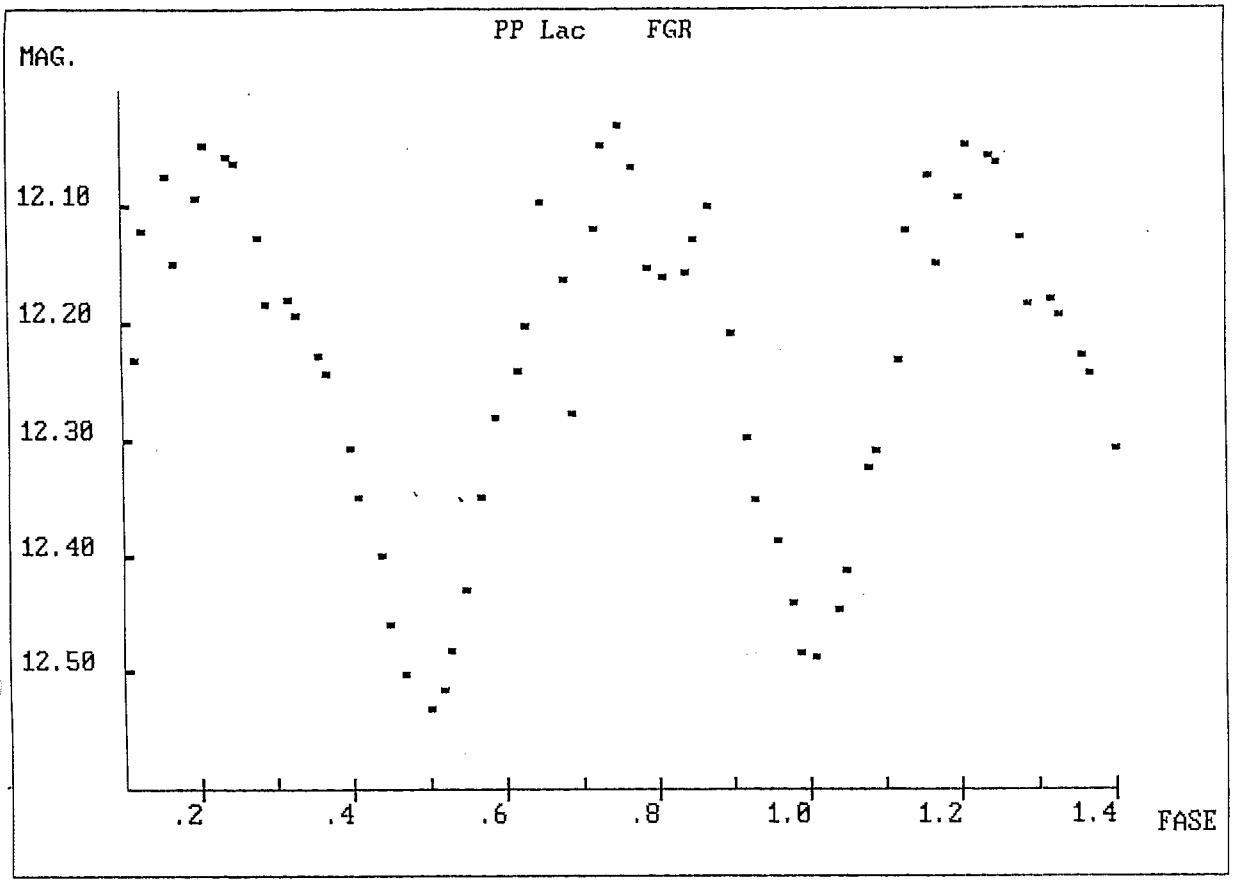
PP Lac FGR
MAG.
12.10
12.20
12.30
12.40
12.50
.2
.4
.6
.8
1.0
1.2
1.4
FASE

fig.6

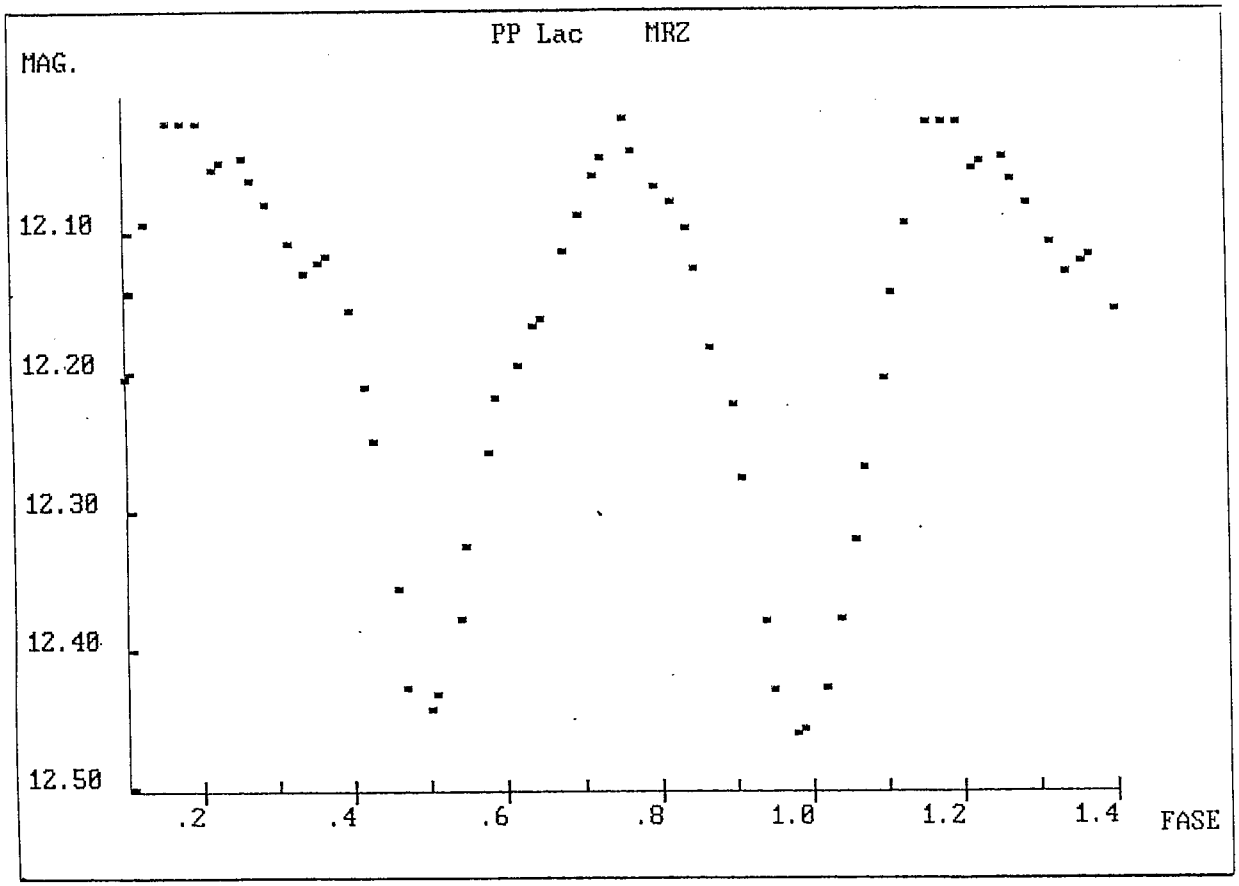
PP Lac MRZ
MAG.
12.10
12.20
12.30
12.40
12.50
.2
.4
.6
.8
1.0
1.2
1.4
FASE

fig.7

Minimi PP Lac
effemeride: 2442903.235 + 0.4011615 * E

n	obs	min. jd hel. 2440000+...	E	O-C
1	FGR	3023.391	299.500	0.008
2	FGR	3040.625	342.500	-0.008
3	FGR	3041.402	344.500	-0.033
4	FGR	3042.411	347.000	-0.027
5	FGR	3050.441	367.000	-0.020
6	FGR	3068.321	411.500	0.008
7	FGR	3068.516	412.000	0.002
8	FGR	3069.312	414.000	-0.004
9	RAL	3096.396	481.500	0.002
10	LSA	3096.406	481.500	0.012
11	FGR	3101.417	494.000	0.008
12	FGR	3102.422	496.500	0.010
13	FGR	3104.412	501.500	-0.005
14	FGR	3123.272	548.500	0.000
15	KL	3188.666	711.500	0.005
16	KL	3189.668	714.000	0.004
17	KL	3291.560	968.000	0.001
18	KL	3292.573	970.500	0.011
19	FGR	3292.576	970.500	0.014
20	FGR	3358.552	1135.000	-0.001
21	RAL	3361.375	1142.000	0.014
22	RML	3361.379	1142.000	0.018
23	FGR	3361.556	1142.500	-0.006
24	RAL	3361.562	1142.500	0.000
25	RAL	3363.364	1147.000	-0.003
26	GUI	3363.370	1147.000	0.003
27	MPN	3363.383	1147.000	0.016
28	RAL	3364.371	1149.500	0.001
29	GUI	3364.372	1149.500	0.002
30	FGR	3364.377	1149.500	0.007
31	BNN	3364.381	1149.500	0.011
32	FGR	3364.558	1150.000	-0.013
33	RAL	3364.565	1150.000	-0.006
34	RML	3364.570	1150.000	-0.001
35	BNN	3364.571	1150.000	0.000
36	MPN	3364.582	1150.000	0.011
37	GRY	3364.587	1150.000	0.016
38	FLB	3364.588	1150.000	0.017
39	FGR	3370.589	1165.000	0.001
40	FGR	3386.433	1204.500	-0.001
41	FGR	3388.447	1209.500	0.007
42	FGR	3391.445	1217.000	-0.004
43	FGR	3392.442	1219.500	-0.009
44	FGR	3396.464	1229.500	0.001
45	FGR	3397.457	1232.000	-0.009
46	FGR	3398.456	1234.500	-0.013
47	KL	3417.321	1281.500	-0.002
48	FGR	3427.361	1306.500	0.009
49	FGR	3428.362	1309.000	0.007

Minimi PP Lac
effemeride: 2442903.235 + 0.4011615 * E

n	obs	min. jd hel. 2440000+...	E	O-C
50	FGR	3432.369	1319.000	0.002
51	FGR	3495.346	1476.000	-0.003
52	FGR	3496.352	1478.500	0.000
53	FGR	3690.502	1962.500	-0.012
54	FGR	3705.561	2000.000	0.003
55	FGR	3712.574	2017.500	-0.004
56	KL	3715.387	2024.500	0.001
57	KL	3717.401	2029.500	0.009
58	RAL	3718.573	2032.500	-0.023
59	FGR	3718.575	2032.500	-0.021
60	KL	3719.398	2034.500	0.000
61	RAL	3720.405	2037.000	0.004
62	KL	3723.405	2044.500	-0.005
63	KL	3725.414	2049.500	-0.001
64	FGR	3733.435	2069.500	-0.004
65	FGR	3740.457	2087.000	-0.002
66	FGR	3741.462	2089.500	0.000
67	FGR	3746.493	2102.000	0.017
68	FGR	3747.487	2104.500	0.008
69	FGR	3765.337	2149.000	0.006
70	FGR	3767.340	2154.000	0.003
71	FGR	3767.530	2154.500	-0.007
72	FGR	3768.342	2156.500	0.002
73	RAL	3770.346	2161.500	0.000
74	FGR	3770.355	2161.500	0.009
75	FGR	3776.355	2176.500	-0.008
76	FGR	3784.385	2196.500	-0.001
77	FGR	3789.382	2209.000	-0.019
78	FGR	3793.382	2219.000	-0.030
79	KL	3823.292	2293.500	-0.007
80	FGR	3825.290	2298.500	-0.015
81	KL	3950.662	2611.000	-0.006
82	KL	4036.517	2825.000	0.001
83	KL	4072.428	2914.500	0.008
84	KL	4077.463	2927.000	0.028
85	KL	4122.372	3039.000	0.007
86	FGR	4143.436	3091.500	0.010
87	FGR	4152.465	3114.000	0.013
88	KL	4178.300	3178.500	-0.027
89	FGR	4180.322	3183.500	-0.011
90	KL	4181.335	3186.000	-0.001
91	FGR	4489.409	3954.000	-0.019
92	FGR	4490.427	3956.500	-0.003
93	MRN	4490.440	3956.500	0.010
94	FGR	4498.437	3976.500	-0.017
95	FGR	4515.313	4018.500	0.011
96	FGR	4599.357	4228.000	0.011
97	FGR	4792.515	4709.500	0.010
98	FGR	4804.539	4739.500	-0.001

Minimi PP Lac
effemeride: 2442903.235 + 0.4011615 * E

n	obs	min. jd hel. 2440000+...	E	O-C
99	FGR	4810.555	4754.500	-0.002
100	RAL	4812.561	4759.500	-0.002
101	FGR	4812.562	4759.500	-0.001
102	FGR	4814.564	4764.500	-0.005
103	FGR	4816.566	4769.500	-0.009
104	FGR	4844.458	4839.000	0.003
105	FGR	4853.481	4861.500	-0.001
106	FGR	5266.486	5891.000	0.009
107	FGR	5267.272	5893.000	-0.008
108	FGR	5294.363	5960.500	0.005
109	BTL	5561.532	6626.500	0.000
110	FND	5561.541	6626.500	0.009
111	RVS	5561.554	6626.500	0.022
112	RAL	5562.538	6629.000	0.003
113	WLS	5577.373	6666.000	-0.005
114	WLS	5578.383	6668.500	0.003
115	WLS	5583.390	6681.000	-0.005
116	WLS	5595.437	6711.000	0.007
117	WLS	5603.451	6731.000	-0.002
118	WLS	5882.459	7426.500	-0.002
119	WLS	5887.470	7439.000	-0.005
120	WLS	5889.481	7444.000	0.000
121	WLS	5904.523	7481.500	-0.002
122	WLS	5906.525	7486.500	-0.006
123	WLS	5910.547	7496.500	0.005
124	RAL	6303.480	8476.000	0.000
125	MRZ	6319.329	8515.500	0.003
126	MRZ	6320.329	8518.000	0.000
127	MRZ	6625.416	9278.500	0.004
128	BFF	6651.487	9343.500	0.000
129	MRZ	6651.492	9343.500	0.005
130	MRZ	6652.494	9346.000	0.004
131	MRZ	6676.358	9405.500	-0.001
132	MRZ	6677.358	9408.000	-0.004
133	MRZ	6678.375	9410.500	0.010
134	MRZ	6680.377	9415.500	0.006
135	MRZ	6682.380	9420.500	0.003
136	MRZ	7024.364	10273.000	-0.003
137	MRZ	7025.378	10275.500	0.008
138	MRZ	7035.396	10300.500	-0.003
139	MRZ	7037.394	10305.500	-0.011
140	MRZ	7038.400	10308.000	-0.008
141	PMP	7115.430	10500.000	-0.001
142	MRZ	7353.515	11093.500	-0.005
143	MRZ	7357.531	11103.500	-0.001
144	MRZ	7376.383	11150.500	-0.003
145	MRZ	7377.385	11153.000	-0.004
146	MRZ	7379.388	11158.000	-0.007