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OBSERVATIONS OF CY AQUARII 1981-1984 AND RECENT EVOLUTION OF THE PERIOD

ABSTRACT - The present paper dealing with the maxima of CY Aqr is essentially composed of two parts. The first part summarizes the results secured by GEOS observers from 1981 to 1984. A mean maximum is given for each year. In the second part, these results are compared with all the observations published during the last 20 years. It appears that the period of CY Aqr has not noticeably changed during that interval. A linear regression applied to the observations of the past 20 years led to a new ephemeris (4), which is in good agreement with all results. Finally, the timing of the maxima of CY Aqr appears to be well within the reach of visual observers, provided that some care be taken in order to achieve a high degree of accuracy.

RESUMEN - El presente estudio, referido a los máximos de CY Aqr, comprende esencialmente dos partes. En la primera se presentan los resultados obtenidos por los observadores del GEOS durante los años 1981 a 84. Se indica un máximo promedio para cada uno de estos años. En la segunda parte se comparan los resultados precedentes a todas las observaciones que han sido publicadas en los últimos 20 años. De ello se desprende que el periodo de CY Aqr no ha variado sensiblemente desde 1964. Una regresión linear a partir de las observaciones de los últimos 20 años ha permitido obtener una efeméride (4) que ajusta correctamente todos los resultados. Finalmente, la determinación de los máximos de CY Aqr parece ser perfectamente accesible a los observadores visuales, siempre y cuando se tomen ciertas precauciones imprescindibles para lograr una elevada precisión.

SOMMARIO - Il presente studio sui massimi di CY Aqr si compone essenzialmente di due parti. Nella prima sono presentati i risultati ottenuti dagli osservatori GEOS negli anni dall'81 all'84. Per ciascuno di tali anni è stato ricavato un massimo medio. Nella seconda parte, questi risultati vengono confrontati con tutte le osservazioni pubblicate negli ultimi 20 anni. Sembrerebbe che il periodo di CY Aqr non abbia subito cambiamenti significativi dopo il 1964. Una regressione lineare a partire dalle osservazioni degli ultimi 20 anni ha permesso di ottenere un'effemeride (4) che ben soddisfa tutti i risultati. Per finire, la determinazione dei massimi di CY Aqr appare essere bene alla portata degli osservatori visuali purchè si rispettino alcune precauzioni necessarie per ottenere una precisione elevata.

RESUME - La presente étude, qui concerne les maximums de CY Aqr, comporte deux parties. Dans la première, sont présentés les résultats obtenus par les observateurs du GEOS pendant les années 1981 à 84. Un maximum moyen est donné pour chacune de ces années. Dans la seconde partie les résultats précédents sont comparés à toutes les observations qui ont été publiées depuis 20 ans. Il apparait que la période de CY Aqr n'a pas sensiblement changé depuis 1964. Une régression linéaire à partir des observations des 20 dernières années a permis d'obtenir une éphéméride (4), qui rend bien compte de tous les résultats. Finalement, la détermination des maximums de CY Aqr apparait bien à la portée des observateurs visuels, moyennant certaines précautions nécessaires pour atteindre une précision élevée.

1. INTRODUCTION.

CY Aquarii has long remained the dwarf cepheid with the shortest known period : 0.061 d, i.e. 88 mn ; and owing to its great amplitude : 10.42 to 11.16 V (Kholopov et al., 1985), its observation is quite spectacular. This partly explains why so much literature is available on this star. Yet, it offers other matters for surprise.

Its variability was discovered by Hoffmeister in 1934, and in the following years, many observers published timings of maxima that were more or less accurate. A decrease in the period of CY Aqr was first noticed by Hardie and Tolbert (1961) who tried to fit the variations of the O-C's by a parabola.

This interpretation was refuted by Zissell (1968), who explains the decrease by a sudden change in the period occuring between 1940 and 1953, an interval during which observations are scanty. His study is not based on times of maximum light, but on what he terms "the critical point" on the ascending branch of the light curve which, according to him, can be determined with higher accuracy than the time of maximum light.

From that time on, most of the observers have noted that the shape of the light curve is slightly variable, as well as the amplitude. The light curves do not exactly overlap from one cycle to another.

Next, many authors have looked for a beat period (Elst, 1972 ; Fitch 1973 ; Figer, 1978) but their results differ, and none is really convincing.

In the meantime, Percy (1975) collected all the available times of maxima in an exhaustive synthesis, and confirmed a decrease in the period which he dated of 1951. Among the dwarf cepheids, CY Aqr is one of the few stars for which a clear change in the period has been evidenced (Percy, 1980) ; it is also one of the few stars of that type that seems to belong to population II. According to Sweigart and Renzini (1979), the sudden change in the period could be accounted for by perturbations in the semi-convective layer of the star.

Recently, the variations of the period of CY Aqr have been confirmed and assessed more accurately from compilations by Mahdy and Szeidl (1980), Bohusz and Udalski (1980), Kämper (1985), A. Rolland et al. (1986). The latter, just as Hardie and Tolbert 25 years before, fit the variations of the O-C's by a parabola and give an ephemeris with an E^2 corrective term. As for Kämper, he continued the work of Zissell until 1984, using the method of the "critical point", and suspected two slight changes in period around 1966 and 1977.

At GEOS, the observation of CY Aqr was initiated in 1974 and gained some momentum in 1975 with the European Observing Program on RR Lyr stars. The star was then under regular monitoring every year, and some results have already been published elsewhere (Romoli, 1975 ; R. Rolland, 1976 ; Figer, 1978 ; Boninsegna, 1981 ; Ralincourt, 1982 ; Dumont, 1983).

In the last edition of the General Catalogue of Variable Stars (GCV Kholopov et al, 1985), CY Aqr is now classified as an SX Phe star with the ephemeris of Mahdy and Szeidl :

Max. Hel. = J.D. 2434308.4314 + 0.061038328 E (1)

However, to ensure an easier comparison with previously published articles and observations, the elements used in this paper are those of the 3rd supplement to the 3rd edition of the GCVS (Kukarkin et al 1976) :

Max. Hel. = J.D. 2441959.4018 + 0.061038354 E (2)

and the ephemeris of A. Rolland et al. (1986) with a quadratic term will also be used, i.e. :

Max. Hel. = J.D. 2440892.6370 + 0.061038318E − $4.58\times10^{-13}\,E^2$ (3)

2. 1981-1984 OBSERVATIONS.

To prepare this paper, all the observations of maxima secured and sent by the GEOS members have been analysed. Table 1 gives the list of observers, their identification acronym, the observing site, and for each year the number of estimates followed by the number of maxima that were observed. Figure 1 gives the chart for CY Aqr (Figer, 1975) and the comparison stars used by all the observers.

Observer	Acronym	Site	1981	1982	1983	1984	Total
Alain Figer	FGR	F-Paris	--	262/16	236/11	98/4	596/31
Philippe Ralincourt	RAL	F-Nantes	--	256/13	--	286/10	542/23
Mino Benucci	BEN	I-Firenze	--	206/16	78/4	--	284/20
Jaime Busquets	BSQ	E-Valencia	--	212/13	65/2	--	277/15
Pascal Guiraudou	GUI	F-Montpellier	--	208/14	--	--	208/14
Roland Boninsegna	BNN	B-Dourbes	--	184/13	--	--	184/13
Juan Fabregat	FBG	E-Valencia	--	193/11	--	--	193/11
Pietro Baruffetti	BFF	I-Massa	--	--	147/8	37/2	184/10
Carlo Barani	BAR	I-Codogno	--	--	118/6	--	118/6
Stéphane Ferrand	FND	F-Bougival	--	--	114/6	--	114/6
Alberto Cora	COA	I-Torino	--	--	--	219/5	219/5
Fabrizio Coppola	COP	I-M. di Massa	154/5	--	--	--	154/5
Luca Maccarini	MAC	I-Sampierdarena	--	--	85/3	--	85/3
Michel Frangeul	FRL	F-Angers	56/2	--	--	--	56/2
Giuliano Pacifico	PAC	I-Massa	--	--	--	22/2	22/2
Guy Boistel	BTL	F-Nantes	--	--	--	24/1	24/1
Total			210/7	1521/96	843/40	686/24	3260/ 167

Tab. 1 : List of observers ; number of estimates and observed maxima.

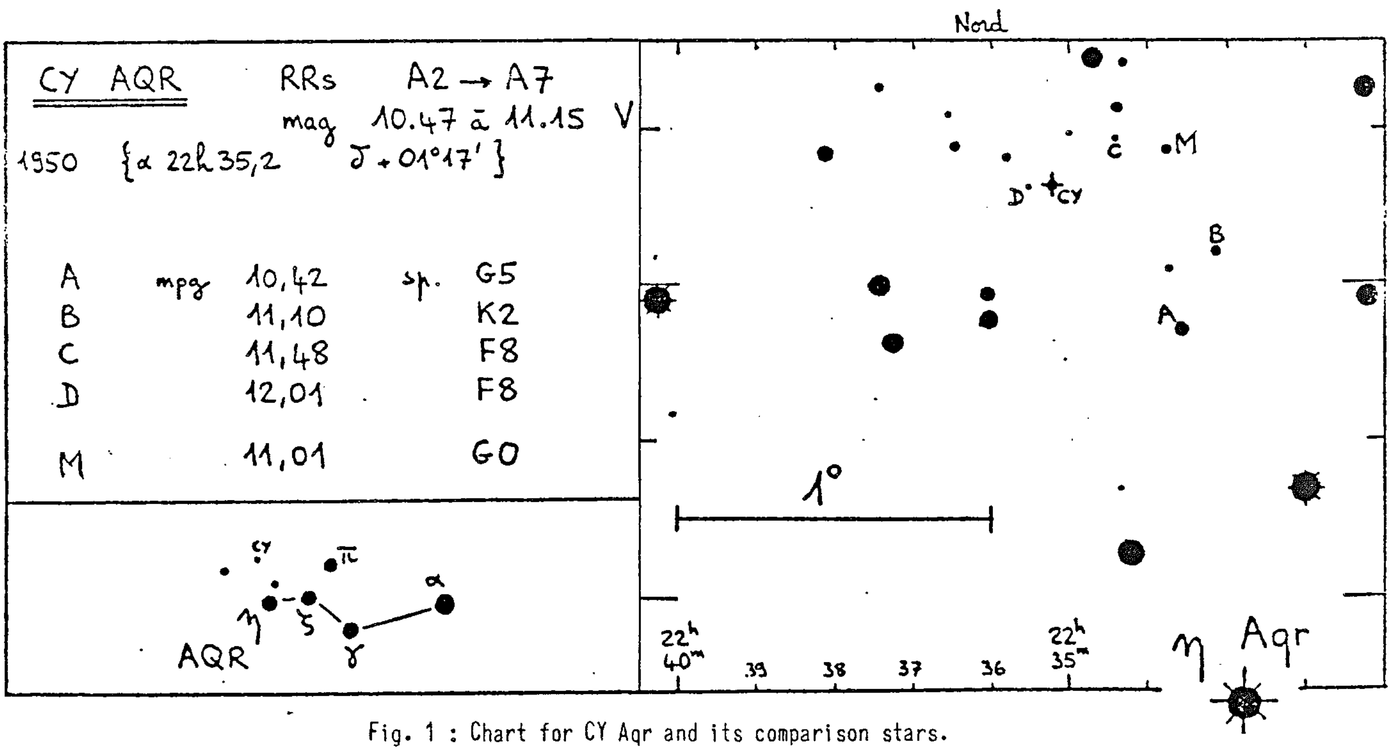

Fig. 1 : Chart for CY Aqr and its comparison stars.

Taking the differences in brightness noted by the observers between the comparison stars, it was possible to calculate a personal sequence for each of the observers, by means of a least-squares fit on the photographic magnitudes. Light curves were then plotted for each observer, and a mean light curve was derived from many individual light curves. Finally, the times of maximum light were obtained by finding manually, for each curve, the best fit with the mean curve. For each maximum, the fit was repeated three times after an interval of several days, to minimize possible systematic errors. The results thus derived were averaged with the determination made by the observer himself, yielding lastly the value retained for this paper.

Table 2 summarizes all the results. The times of maxima are given in days and hours (UT geocentric) then in Julian Date (heliocentric) and the O-C's are referred to ephemeris (2). An examination of the table shows that the year 1982 yielded the greatest number of results. This is also the year on which the results were the most homogeneous. These maxima were indeed secured during the camp at Bédarieux (Hérault, France) from 1982 July 16 to 29, by 7 well-trained observers. Though some quite positive O-C's can be noticed for the first nights, the results improve with time and the majority of the O-C's become negative for most of the observers, typically between -0.0025 and +0.0015 for a maximum.

The problem is now to compare these maxima between them, as well as with the maxima already published. Before that, some individual curves (fig. 2, 3, 4, 5) will give a good idea of the visual estimates made by different observers.

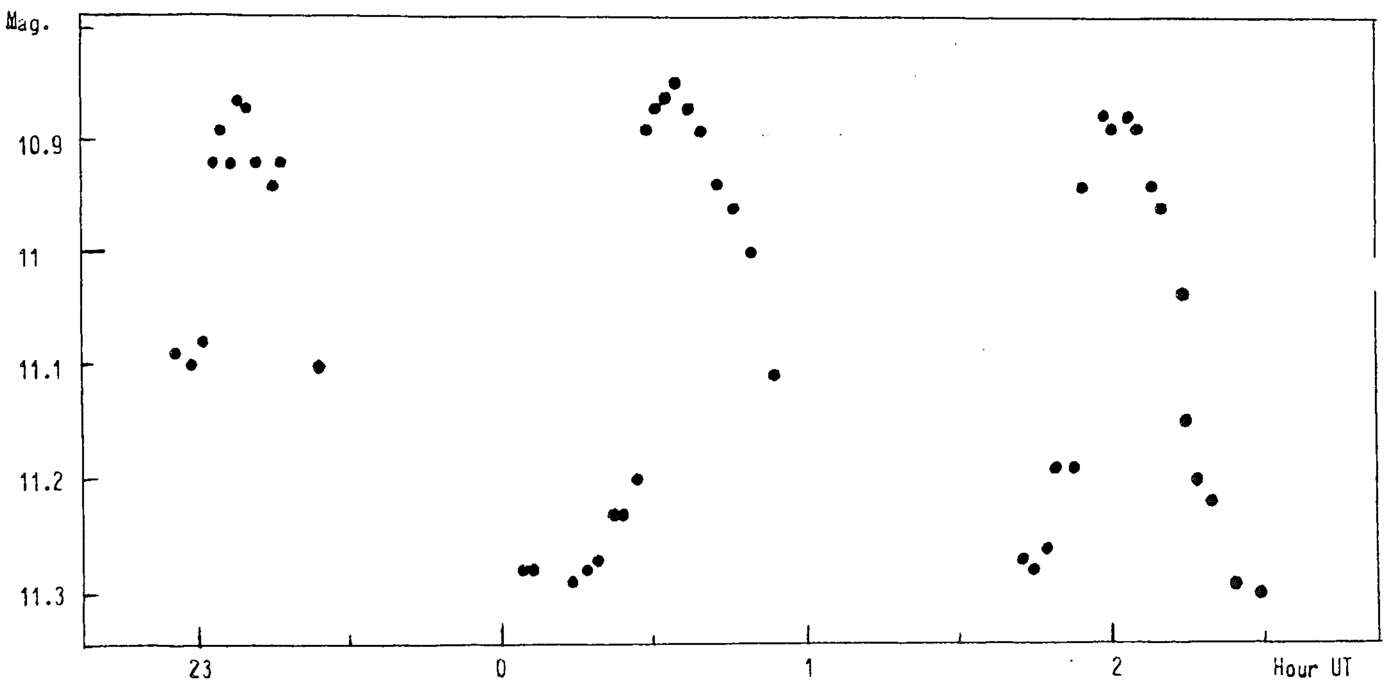

Fig. 2 : CY Aqr observed visually by J. Busquets on 1982 July 26
(owing to the method used, the magnitude scale depends on the observer, see text).

Geoc. time of max. Date (UT)	h mn	Hel. time JD − 2440000	$O-C_{(2)}$	Observer
5 SEP 81	21 45	4853.4120	− 0.0013	FRL
5	23 17	4853.4758	+ 0.0015	FRL
8 NOV	18 11	4917.2601	+ 0.0007	COP
8	19 37	4917.3199	− 0.0005	COP
8	21 03.2	4917.3797	− 0.0018	COP
10	18 26 :	4919.2704	− 0.0033	COP
10	19 55.7	4919.3326	− 0.0021	COP
19 JUL 82	2 02.4	5169.5890	− 0.0030	GUI
19	2 05.9	5169.5914	− 0.0006	FGR
21	1 00.7	5171.5463	+ 0.0011	FGR
21	1 02.5	5171.5475	+ 0.0023	GUI
21	2 30.5	5171.6086	+ 0.0024	FGR
21	2 34.5	5171.6114	+ 0.0052	GUI
22	23 52.0	5173.4986	+ 0.0002	BNN
22	23 53.3	5173.4995	+ 0.0011	BEN
22	23 53.3	5173.4995	+ 0.0011	FBG
22	23 53.5	5173.4997	+ 0.0013	GUI
22	23 58.0	5173.5028	+ 0.0044	BSQ
22	23 58.2	5173.5029	+ 0.0045	RAL
22	23 59.0	5173.5035	+ 0.0051	FGR
23	1 17.2	5173.5578	− 0.0016	BNN
23	1 17.8	5173.5582	− 0.0012	BSQ
23	1 20.7	5173.5602	+ 0.0008	FBG
23	1 20.7	5173.5602	+ 0.0008	RAL
23	1 21.2	5173.5606	+ 0.0012	BEN
23	1 21.9	5173.5611	+ 0.0017	FGR
23	2 45.0	5173.6188	− 0.0017	RAL
23	2 45.1	5173.6189	− 0.0016	BSQ
23	2 46.0	5173.6195	− 0.0010	BEN
23	2 48.3	5173.6211	+ 0.0006	FBG
23	2 51.1	5173.6230	+ 0.0025	BNN
23	2 51.9	5173.6236	+ 0.0031	FGR
24	0 46.9	5174.5369	+ 0.0008	GUI
24	0 50.0	5174.5390	+ 0.0029	BEN
24	2 09.3	5174.5941	− 0.0030	BSQ
24	2 10.4	5174.5949	− 0.0022	BEN
24	2 11.1	5174.5953	− 0.0018	GUI
24	2 12.2	5174.5961	− 0.0010	FGR
24	2 12.5	5174.5963	− 0.0008	RAL
24	2 14.5	5174.5977	+ 0.0006	BNN
25	23 33.7	5176.4861	− 0.0032	BSQ
25	23 36.7	5176.4882	− 0.0011	RAL
25	23 37.2	5176.4886	− 0.0007	FBG
25	23 37.7	5176.4889	− 0.0004	BNN
25	23 39.5	5176.4902	+ 0.0009	BEN
25	23 40.0	5176.4905	+ 0.0012	FGR
26	1 02.4	5176.5477	− 0.0026	BNN
26	1 05.2	5176.5497	− 0.0006	BEN
26	1 05.5	5176.5499	− 0.0004	RAL
26	1 06.0	5176.5502	− 0.0001	GUI
26	1 06.7	5176.5507	+ 0.0004	BSQ
26	1 07.2	5176.5511	+ 0.0008	FBG
26 JUL 82	1 08.5	5176.5520	+ 0.0017	FGR
26	2 31.5	5176.6096	− 0.0018	BNN
26	2 32.4	5176.6102	− 0.0012	RAL
26	2 32.5	5176.6103	− 0.0011	BSQ
26	2 33.5	5176.6110	− 0.0004	GUI
26	2 34.0	5176.6113	− 0.0001	FBG
26	2 35.0	5176.6120	+ 0.0006	BEN
26	2 35.4	5176.6123	+ 0.0009	FGR
26	23 00.0	5177.4628	− 0.0031	BNN
26	23 01.7	5177.4640	− 0.0019	RAL
26	23 02.7	5177.4647	− 0.0012	FGR
26	23 03.9	5177.4655	− 0.0004	GUI
26	23 04.2	5177.4658	− 0.0001	FBG
26	23 07.0	5177.4677	+ 0.0018	BSQ
26	23 08.1	5177.4685	+ 0.0026	BEN
27	0 28.4	5177.5242	− 0.0027	FBG
27	0 28.5	5177.5243	− 0.0026	BEN
27	0 29.3	5177.5248	− 0.0021	GUI
27	0 29.5	5177.5250	− 0.0019	RAL
27	0 30.0	5177.5253	− 0.0016	BNN
27	0 33.9	5177.5280	+ 0.0011	BSQ
27	0 34.5	5177.5285	+ 0.0016	FGR
27	1 57.3	5177.5860	− 0.0020	RAL
27	1 57.7	5177.5862	− 0.0018	BNN
27	1 58.5	5177.5868	− 0.0012	BEN
27	1 59.5	5177.5875	− 0.0005	FGR
27	2 00.0	5177.5878	− 0.0002	BSQ
27	2 00.0	5177.5878	− 0.0002	FBG
27	2 01.1	5177.5886	+ 0.0006	GUI
27	23 56.0	5178.5017	− 0.0019	BEN
27	23 57.0	5178.5024	− 0.0012	BNN
27	23 58.6	5178.5035	− 0.0001	FBG
27	23 58.7	5178.5036	0	RAL
28	0 00.0	5178.5045	+ 0.0009	BSQ
28	0 00.0	5178.5045	+ 0.0009	FGR
28	0 02.8	5178.5064	+ 0.0028	GUI
28	1 24.1	5178.5629	− 0.0017	BNN
28	1 25.0	5178.5635	− 0.0011	BSQ
28	1 26.1	5178.5643	− 0.0003	RAL
28	1 27.0	5178.5649	+ 0.0003	BEN
28	1 27.4	5178.5652	+ 0.0006	FGR
28	1 28.7	5178.5661	+ 0.0015	GUI
28	2 50.0	5178.6226	− 0.0030	GUI
28	2 51.0	5178.6233	− 0.0023	BEN
28	2 51.5	5178.6236	− 0.0020	RAL
28	2 53.3	5178.6248	− 0.0008	BNN
28	2 53.4	5178.6249	− 0.0007	BSQ
28	2 54.5	5178.6257	+ 0.0001	FBG
28	2 55.4	5178.6263	+ 0.0007	FGR
12 AUG	0 17.9	5193.5176	− 0.0014	BEN
12	1 50.5	5193.5819	+ 0.0019	BEN
31 JUL 83	1 23.4	5546.5626	− 0.0022	BEN

Tab. 2 : Maxima observed from 1981 to 1984.

Geoc. time of max. Date (UT)	h mn	Hel. time JD - 2440000	O-C(2)	Observer
1 AUG 83	0 51.0	5547.5401	- 0.0013	BEN
6	0 57.2	5552.5447	- 0.0019	FND
6	2 25.1	5552.6058	- 0.0018	FND
7	23 51 :	5554.4988	- 0.0010	BAR
8	21 47 :	5555.4127	- 0.0027	BFF
8	23 15	5555.4738	- 0.0026	BAR
8	23 15.5	5555.4742	- 0.0022	BFF
9	0 46.0	5555.5370	- 0.0005	BEN
9	2 12.3	5555.5970	- 0.0015	BEN
12	22 29.3	5559.4423	- 0.0016	FND
12	23 58.5	5559.5043	- 0.0007	BAR
12	23 59.5	5559.5050	0	BFF
13	0 03.4	5559.5077	+ 0.0027	FND
13	1 25.0	5559.5643	- 0.0017	MAC
13	1 26.5	5559.5654	- 0.0006	BFF
13	1 26.9	5559.5656	- 0.0004	FND
13	1 27.0	5559.5657	- 0.0003	BAR
13	21 55.0	5560.4185	- 0.0020	BAR
13	21 57.0	5560.4199	- 0.0006	MAC
13	21 57.3	5560.4201	- 0.0004	BFF
14	21 22.0	5561.3956	- 0.0015	BFF
14	21 23.0	5561.3963	- 0.0008	MAC
14	22 56.5	5561.4612	+ 0.0030	BFF
15	1 45.5	5561.5786	- 0.0017	BSQ
15	1 46.2	5561.5790	- 0.0013	BFF
15	1 47.0	5561.5796	- 0.0007	FND
15	1 51.0	5561.5824	+ 0.0021	BAR
15	3 15.5	5561.6411	- 0.0002	BSQ
15	22 19.0	5562.4353	+ 0.0005	FGR
17	22 35.8	5564.4470	- 0.0021	FGR
3 SEP	21 55.0	5581.4189	+ 0.0012	FGR
5	20 44.1	5583.3697	- 0.0013	FGR
25 SEP 83	19 46.1	5603.3290	- 0.0015	FGR
25	21 15.3	5603.3909	- 0.0006	FGR
25	22 46.3	5603.4541	+ 0.0015	FGR
3 OCT	19 44.0	5611.3272	+ 0.0007	FGR
3	22 37.5	5611.4477	- 0.0009	FGR
11	21 03.0	5619.3816	- 0.0020	FGR
22	22 13.5	5630.4298	- 0.0017	FGR
22 JUL 84	0 16 :	5903.5152	- 0.0019	BFF
22	0 21 :	5903.5187	+ 0.0016	PAC
25	3 00	5906.6293	- 0.0008	BFF
25	3 00	5906.6293	- 0.0008	PAC
29	22 44.4	5911.4521	0	COA
30	23 37	5912.4887	- 0.0011	BTL
4 AUG	0 16.4	5916.5163	- 0.0020	RAL
7	0 03.8	5919.5076	- 0.0016	RAL
7	1 30.1	5919.5676	- 0.0026	RAL
7	2 59.2	5919.6294	- 0.0018	RAL
25	22 10.5	5938.4296	- 0.0015	COA
25	23 36.3	5938.4891	- 0.0030	COA
28	21 56.3	5941.4198	- 0.0021	RAL
28	23 25.2	5941.4815	- 0.0015	RAL
29	0 52.6	5941.5422	- 0.0018	RAL
29	22 50.7	5942.4576	- 0.0020	RAL
30	0 19.5	5942.5192	- 0.0014	RAL
30	22 15.3	5943.4330	- 0.0032	RAL
22 SEP	19 44.3	5966.3278	+ 0.0022	COA
14 OCT	19 01.1	5988.2968	- 0.0026	FGR
14	20 29.0	5988.3579	- 0.0025	FGR
14	21 56.5	5988.4186	- 0.0029	FGR
30	18 57.4	6004.2932	+ 0.0018	FGR
24 NOV	19 34.4	6029.3166	- 0.0006	COA

Tab. 2 (continued).

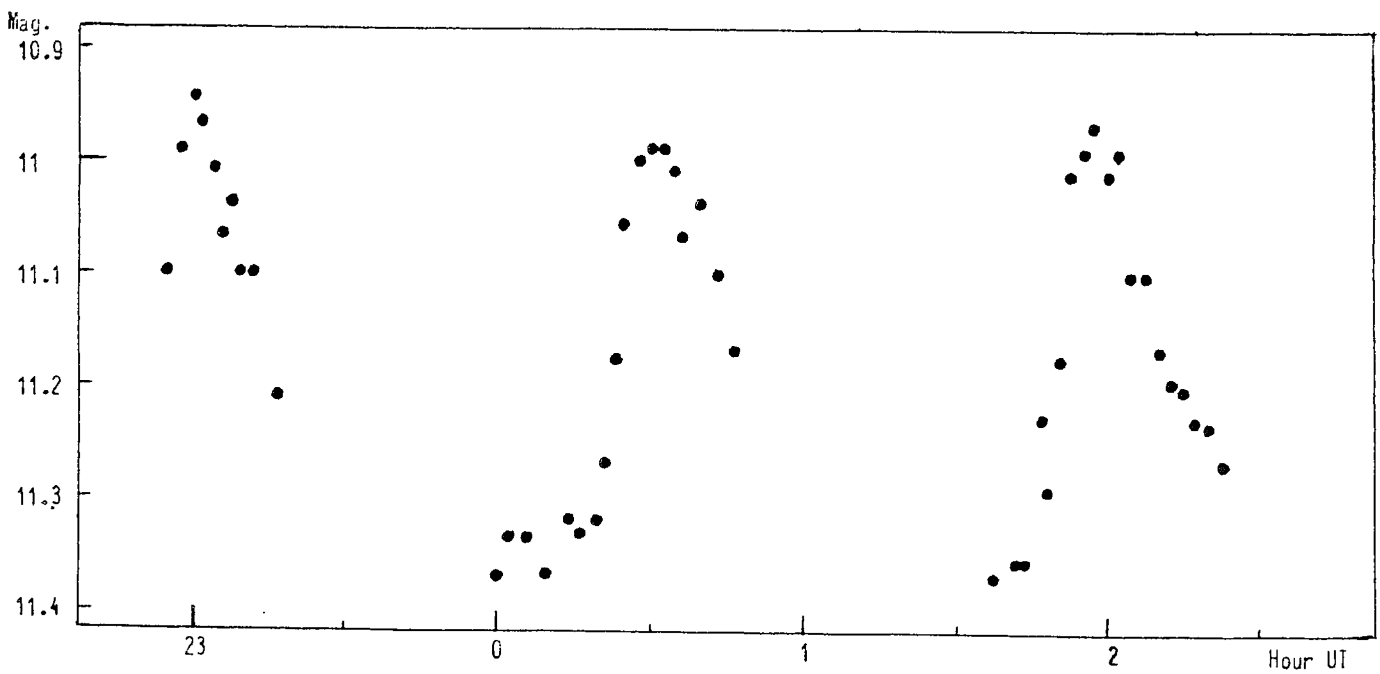

Fig. 3 : CY Aqr observed visually by R. Boninsegna on 1982 July 26.

3. RESULTS (1981-1984).

Our purpose here is to determine a mean maximum for each year. The small number of maxima observed in 1981, 1983 and 1984, and their lack of homogeneity did not allow the determination of significant standard deviations for each observer, thus preventing the calculation of weighted O-C's, as was done in 1980 (Ralincourt, 1982). The maxima of 1982 are more numerous and above all more homogeneous ; however, calculating a weighted mean (in inverse ratio to the square of the standard deviation) yields the same result as a mere averaging of all the O-C's. There is therefore no improvement here.

Table 3 gives the following information on the 7 observers who contributed in 1982 :

- the number N of maxima of an individual observer
- the mean O-C of this observer, as referred to ephemeris (2) : $\overline{O-C}$
- an estimate S of the standard deviation of the observer's O-C's
- the observer's standard error
- W, the weight intervening in the weighted mean, i.e. an $\frac{N}{S^2}$ term (see Poretti, 1981).

	FGR	RAL	BEN	BSQ	GUI	BNN	FBG
N	16	13	16	13	14	13	11
$\overline{O-C}$ x 10^4 d.	+11.1	-6.2	-1.1	-2.7	+2.6	-10.2	-0.4
S x 10^4 d.	16.0	17.7	17.8	20.4	23.2	14.8	10.3
P x 10^4 d.	4.0	4.9	4.4	5.7	6.2	4.1	3.1
W	63	42	52	31	26	59	104

Tab. 3 : Statistics of the maxima observed in 1982.

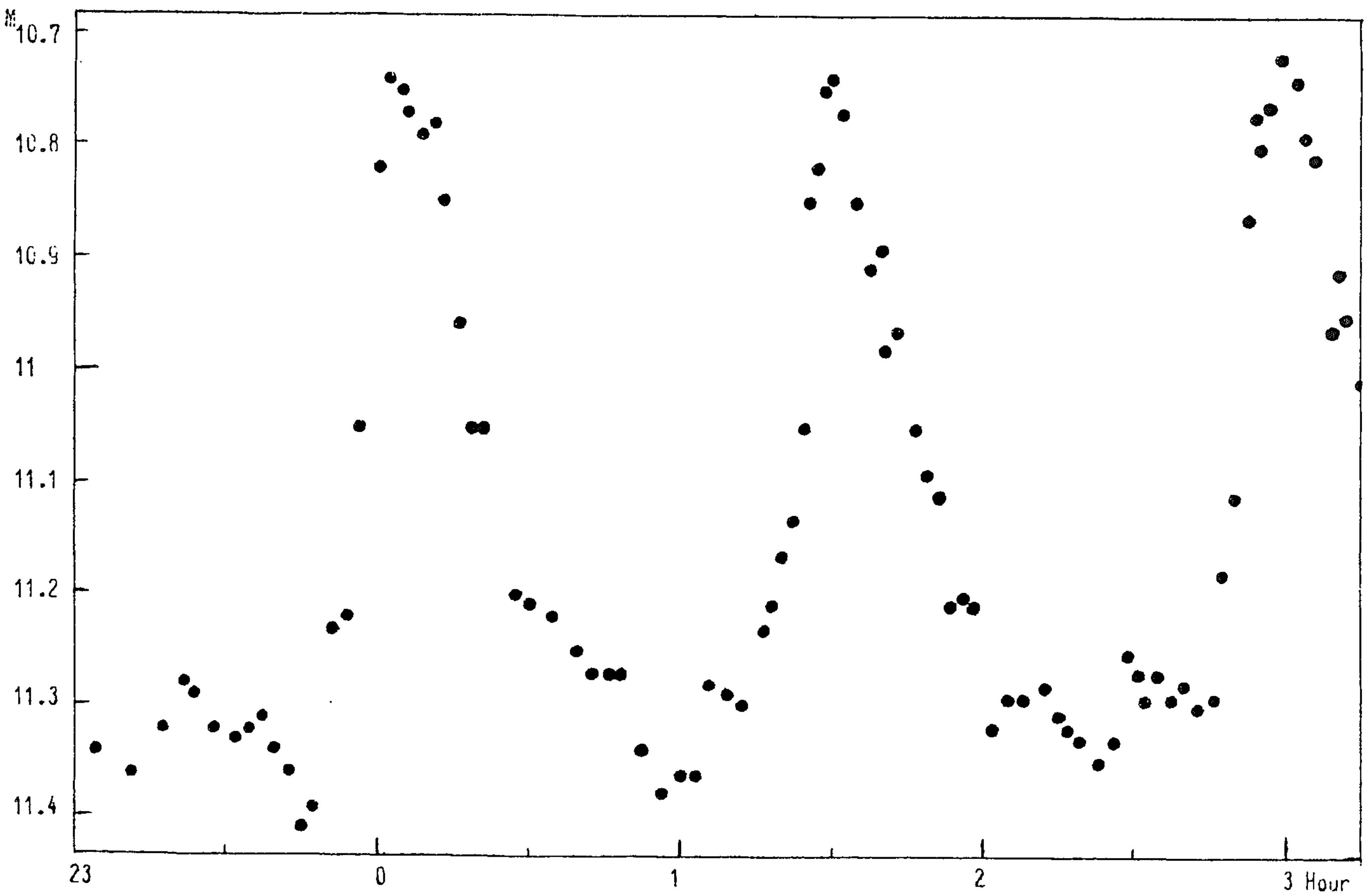

Fig. 4 : CY Aqr observed visually by P. Ralincourt on 1984 August 6.

In Table 4 are summarized the mean O-C's finally obtained for the 4 years of observation, as referred to ephemeris (2). They are followed by the number of elements included in the mean, their standard deviation, and the mean maximum. As a term of comparison, the results found in 1980 are also given.

Year	O-C	Nb.	s	Mean Maximum
1980	- 0.0009	237	0.0023	44465.4526
1981	- 0.0010	7	0.0017	44899.6183
1982	- 0.0001	96	0.0018	45176.4892
1983	- 0.0008	40	0.0014	45568.8430
1984	- 0.0013	24	0.0015	45943.5570

Tab. 4 : Comparison of the yearly mean O-C's from 1980 to 1984 .

4. EXAMINATION OF THE PERIOD.

Many authors have studied since long the variations of the O-C's of CY Aqr, and the change in period that occured in 1951 is now well known. For that reason, it has been decided to study here only the latter behaviour of the star, i.e. for the past 20 years.

To that purpose, all the maxima available in the literature were collected : they are listed in Table 5 together with their respective O-C's relative to ephemerides (2), (3), and (4), the latter being defined further down. The visual observations are grouped by intervals of time (a few days or weeks) and the maxima listed in the table are then mean maxima followed by the number of elements included in the average.

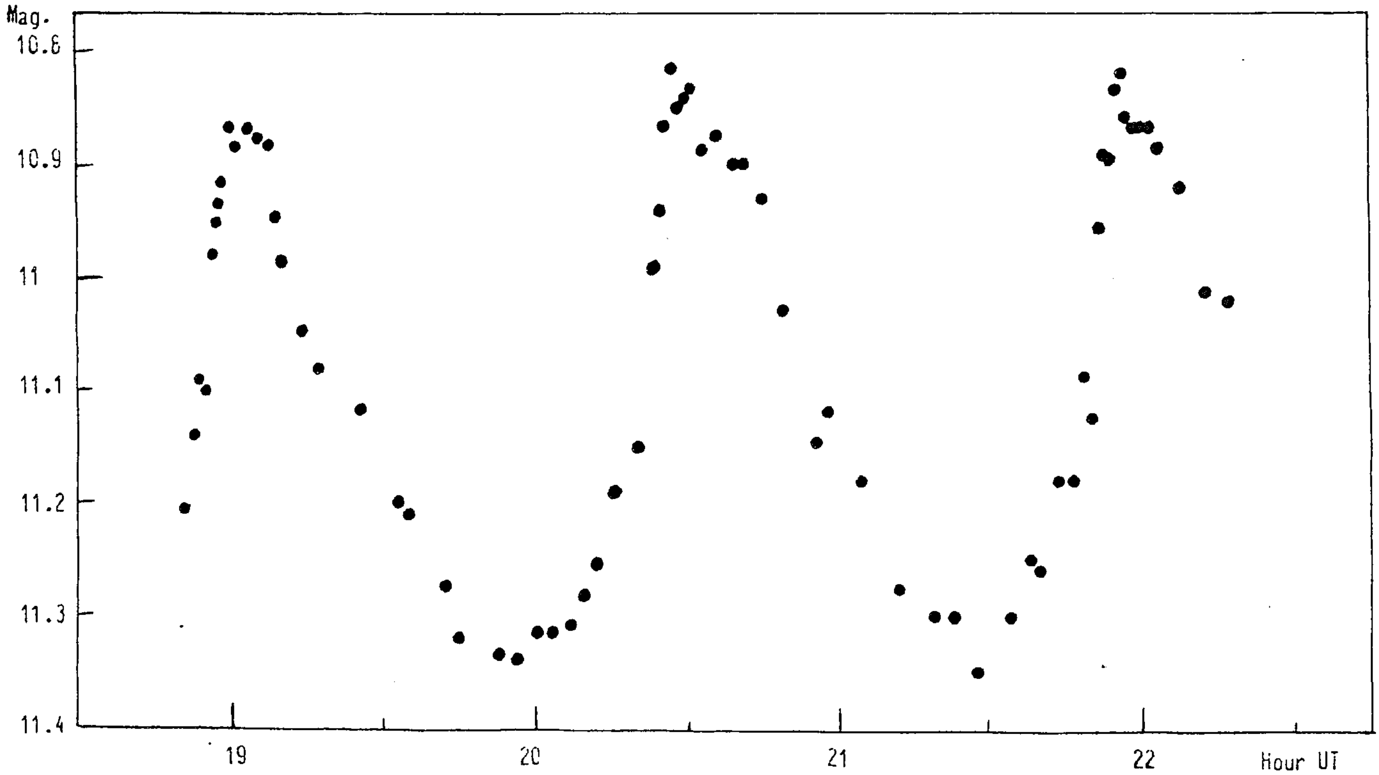

Fig. 5 : CY Aqr observed visually by A. Figer on 1984 October 14.

Hel. time JD-2400000	O-C(2)	O-C(4)	O-C(3)	Author
39350.6861	+.0025	-.0010	-.0006	ZISSELL interpreted
39350.7490	+.0044	+.0009	+.0012	by FITCH
39350.8087	+.0030	-.0004	-.0001	" " "
39350.8692	+.0025	-.0010	-.0006	
39351.7253	+.0041	+.0006	+.0009	
39351.8460	+.0027	-.0008	-.0004	
39355.6920	+.0033	-.0002	+.0001	
39355.7546	+.0048	+.0014	+.0017	
39355.8145	+.0037	+.0002	+.0006	
39355.8763	+.0045	+.0010	+.0013	
39356.7300	+.0036	+.0002	+.0005	
39356.7908	+.0034	-.0001	+.0002	
39356.8527	+.0042	+.0008	+.0011	
39401.5920	+.0024	-.0010	-.0007	
39401.6527	+.0021	-.0013	-.0010	
39401.7139	+.0022	-.0012	-.0009	
39405.6204	+.0023	-.0011	-.0008	
39405.6822	+.0031	-.0004	-.0001	
39405.7428	+.0026	-.0008	-.0005	
39406.5980	+.0033	-.0001	+.0002	
39406.6578	+.0020	-.0014	-.0011	
39406.7196	+.0028	-.0006	-.0003	
40779.7776	+.0030	+.0008	+.0005	ELST determined
40779.8393	+.0037	+.0015	+.0011	by PERCY
40779.9009	+.0043	+.0021	+.0017	" " "
40892.6364	+.0019	-.0002	-.0006	NATHER & WARNER
40894.6507	+.0019	-.0002	-.0006	" " "
41958.3639	-.0002	-.0014	-.0020	GEYER & HOFFMANN
41959.2799	+.0002	-.0010	-.0016	" " "
41959.3405	-.0003	-.0014	-.0020	
41959.4018	.0000	-.0012	-.0017	
41959.4634	+.0006	-.0006	-.0012	
41959.5234	-.0005	-.0016	-.0022	
42297.1309	+.0039	+.0030	+.0024	ROMOLI (64 visual)
42302.5012	+.0028	+.0020	+.0014	FICARROTTA & ROMOLI
42302.5612	+.0018	+.0009	+.0003	" " "
42303.4777	+.0027	+.0018	+.0013	
42303.5372	+.0012	+.0003	-.0003	
42304.3925	+.0019	+.0011	+.0005	
42304.4531	+.0015	+.0006	.0000	
42304.5126	-.0001	-.0009	-.0015	
42627.3454	+.0009	+.0003	-.0002	R. ROLLAND (3 v.)
42640.2294	+.0058	+.0052	+.0047	BRAUNE & al.(3 v.)
43013.2301	+.0011	+.0009	+.0004	FIGER (191 visual)
43345.5240	+.0022	+.0023	+.0019	PERCY & al.78 (5v)
43401.3707	-.0012	-.0011	-.0014	FICARROTTA & ROMOLI
43401.4329	.0000	+.0001	-.0003	" " "
43401.4942	+.0002	+.0004	.0000	
43402.3477	-.0008	-.0007	-.0010	
43402.4088	-.0007	-.0006	-.0010	FICARROTTA & ROMOLI
43402.4704	-.0002	.0000	-.0004	" " "
43402.5317	+.0001	+.0002	-.0002	
43425.4207	-.0003	-.0001	-.0005	BOHUSZ & UDALSKI
43425.4814	-.0006	-.0005	-.0009	" " "
43490.2434	-.0003	-.0001	-.0005	
43490.3038	-.0010	-.0008	-.0011	
43815.3325	-.0015	-.0010	-.0012	
43815.3947	-.0003	+.0002	-.0001	
44465.4526	-.0009	+.0002	+.0003	RALINCOURT (237 v.)
44899.6183	-.0010	+.0004	+.0008	present paper
45176.4892	-.0001	+.0016	+.0022	present paper
45194.7999	-.0009	+.0008	+.0014	A. ROLLAND & al.
45194.8583	-.0035	-.0018	-.0012	" " "
45194.9208	-.0021	-.0004	+.0002	
45195.7756	-.0018	-.0001	+.0005	
45195.8374	-.0010	+.0007	+.0013	
45195.8979	-.0016	+.0001	+.0007	
45199.8034	-.0025	-.0008	-.0002	
45199.9249	-.0031	-.0014	-.0008	
45199.9868	-.0023	-.0005	+.0001	
45207.4944	-.0024	-.0007	.0000	DUMONT
45568.8430	-.0008	+.0012	+.0021	present paper
45611.3853	-.0023	-.0002	+.0007	A. ROLLAND & al.
45611.4465	-.0021	.0000	+.0009	" " "
45612.3625	-.0017	+.0004	+.0013	
45612.4244	-.0008	+.0013	+.0022	
45612.6671	-.0023	-.0002	+.0007	
45612.7268	-.0036	-.0015	-.0006	
45612.7883	-.0031	-.0011	-.0001	
45616.6963	-.0016	+.0005	+.0014	
45616.7563	-.0026	-.0006	+.0004	
45616.8174	-.0026	-.0005	+.0004	
45621.3351	-.0017	+.0004	+.0013	PURGATHOFER & SCHNELL
45629.3301	-.0027	-.0006	+.0003	" " "
45631.2843	-.0018	+.0003	+.0013	
45631.3453	-.0018	+.0003	+.0012	
45635.3122	-.0024	-.0003	+.0007	
45635.3732	-.0024	-.0003	+.0006	
45641.2940	-.0024	-.0003	+.0007	
45641.3550	-.0024	-.0003	+.0007	
45645.2621	-.0017	+.0004	+.0013	
45645.3225	-.0024	-.0003	+.0007	
45651.3634	-.0043	-.0022	-.0012	A. ROLLAND & al.
45661.2532	-.0027	-.0006	+.0004	PURGATHOFER & SCHNELL
45662.2920	-.0015	+.0006	+.0016	" " "
45943.5570	-.0013	+.0011	+.0023	present paper
46055.5612	-.0025	.0000	+.0013	PENA & al.
46062.5806	-.0025	.0000	+.0014	" "
46063.5571	-.0026	-.0001	+.0012	

Tab. 5 : List of the maxima of CY Aqr observed since 1964.
("3 v" , for instance, means : 3 visual maxima)

The corresponding variations of the O-C's are reported in the diagram of fig. 6. The abscissa gives Julian Date at the bottom and year at the top. The ordinate gives the O-C relative to ephemeris (2) : thousandths of day on the left and minutes on the right.

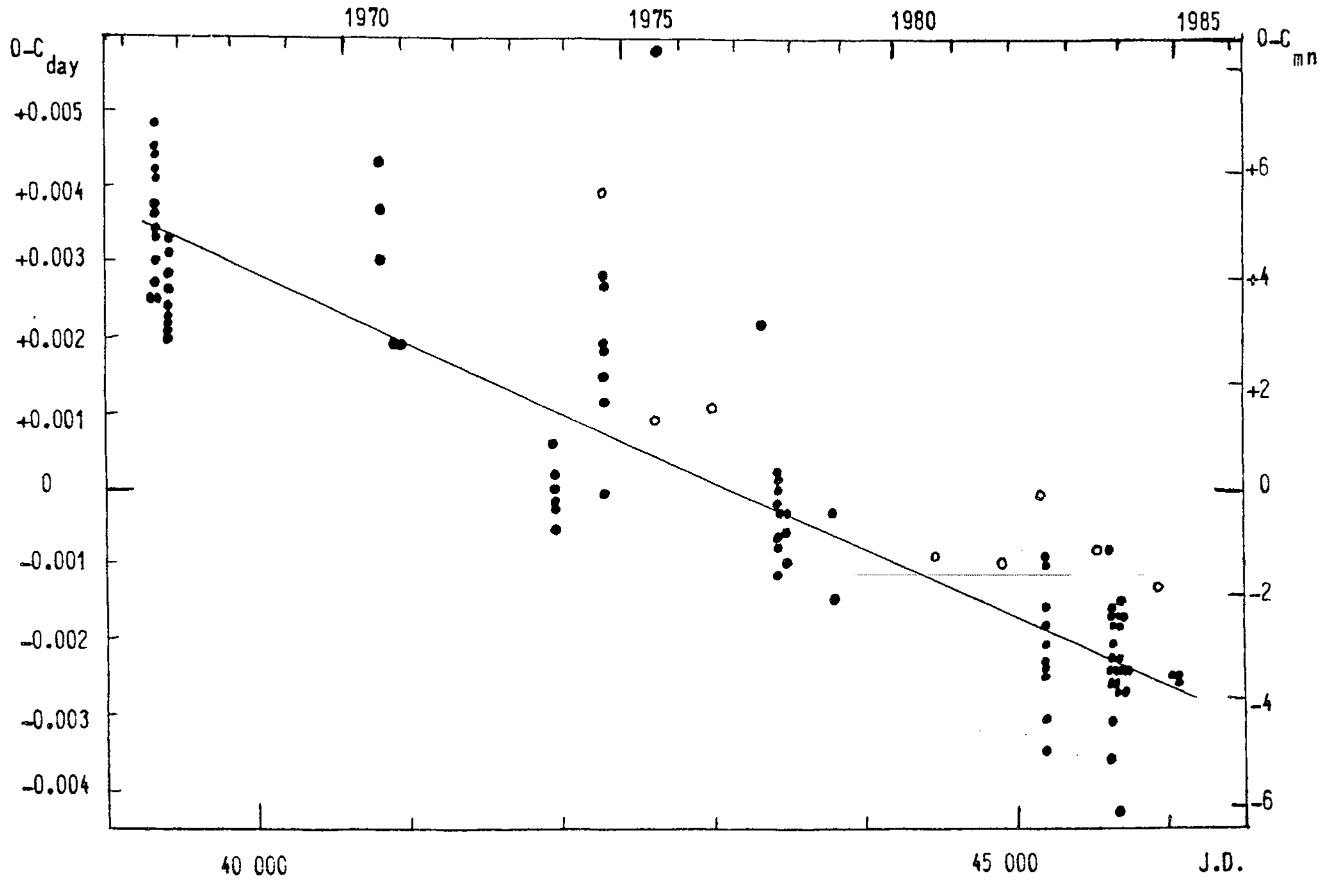

Fig. 6 : Diagram of the variations of the O-C's.

The mean visual O-C's obtained by the GEOS observers are shown by a circle. It can be noted that they are very near the photoelectric results, except in 1974 when the observers were lacking experience, as it was the first year of monitoring. These maxima however slightly lag the photoelectric maxima, generally by 1 or 2 thousandths of a day, i.e. about 1 to 3 minutes. The lag is of the same order as the standard deviation.

In quite a different respect, the general trend of the variation is very close to a straight line, which shows that the period of CY Aqr has remained practically constant for the past 20 years.

Only the observations of Elst in 1970 and Geyer and Hoffmann in 1973 seem to depart from a staight line, but the measures of Nather and Warner, on the one hand, and Ficarrotta and Romoli, on the other hand, do not confirm the respective deviations. The intrinsic scatter of these groups of maxima makes one think of a more complex phenomenon, perhaps linked with variations on a short time-scale.

The downward slope means that the period retained is too long. A linear regression applied to all the available maxima leads to the following new ephemeris :

$$\text{Max. Hel.} = \text{J.D. } 2443220.63735 + 0.0610383000\ E \qquad (4)$$
$$\pm 22 \qquad \pm 56$$
(95 % level of confidence)

which is the ephemeris used for the third column of Table 5.

As can easily be seen, it accounts well for all the observations available since 1965, and the slight change in period around 1977, proposed with caution by Kämper (1985), appears not to be real. Even if the maxima of Zissell (1968) were eliminated, one would obtain a value of $0.0610382916 \pm 48 \times 10^{-10}$ d. for the period, which does not confirm an otherwise dubious increase.

Better still, if an average O-C is calculated for each series of photoelectric observations, it can be seen that the mean O-C's for the series of Zissell, Nather and Warner, Ficarrotta and Romoli (2nd part), Bohusz and Udalski, A.Rolland et al., Pena et al, fall exactly on the straight line plotted in fig. 6. This is good evidence for the consistency of these works, though they are of various origins.

5. CONCLUSION.

It therefore clearly appears that the period of CY Aqr has not noticeably changed for the past 20 years.

However, other phenomena may have an influence on the O-C's : short period variations (a few days or months), a Blazhko effect or a possible beat period which still remains a puzzle in the case of CY Aqr. Such hypotheses were not considered here for lack of a continuous monitoring for several weeks on end, or of new elements that might have been secured after attempts at such a quest from 1972 to 1978. This could be the subject of further research.

One can also retain the fact that monitoring the maxima of CY Aqr is not out of the reach of visual observers. However, to obtain reliable results, each observer must monitor a fairly great number of maxima so that their series might be compared and the influence of possible random or systematic errors reduced. In that respect, A.Rolland et al. (1985) commenting on the GEOS observations of CY Aqr wrote : "the position of the visual observations in the O-C diagram follows the trend of the more accurately determined photoelectric data".

P. Ralincourt

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