(Paper presented at the annual meeting of the B.R.N.O. - Brno Regional Network of Observers, Hvezdarna a planetarium M.Kopernika, Brno, The Czech Rep., Sunday, November 24th 1996)

OBSERVATIONS ON FOUR ECLIPSING BINARIES

1) S ANT

The variable S ANT is a bright eclipsing binary located in the poorly known southern constellation Antlia, but it is well observable from the italian latitudes between late winter and spring.
According to Popper (Astroph.Journal 124,208,1956) this star belongs to the EW/KE sub-class and varies between 6.4 and 6.92 visual magnitudes.
He gives also the spectral type A9+F4 and the only photoelectric light curve published until now.
On the basis of these measures Popper calculated the first light elements as follow:

Min.I = J.d. 2435139.929 + 0.648345 x E

that are listed in the GCVS (Kholopov et al., 1985) too.
Since the paper of Popper I did not find in literature any other studies concerning S ANT with the exception of an unpublished work by Hogg quoted in the references of the Finding List for Observers of Interacting Binary Stars (Wood et al., 1980).
I observed this star visually in 1995: during 5 night I carried out 104 estimations with a medium power binocular; as comparison's stars I used HD 081753 (6.12v) and HD 082363 (6.7v).
As shown in the Fig.2, the shape of the light curve shows a typical example of a W UMa binary.
From these estimations I was able to derive 5 times of minima listed in Tab.1.
I tried an O-C analysis on this variable using my timings together with other visual data published by members of the BBSAG and BAV (Fig.1).
From the O-C diagram the run of the points is not easy to explain.
It seems that the period of S ANT is remained costant through in the time.
The O-C values show significant dispacement from the zero line, but this would be one spurious effect of the atmosphere because S ANT is usually low on the european horizont.
On the contrary, if the observations published are of good quality, as they show in turn positive and negative values of the residuals, it could be supposed a non-linear progress of the residuals over time; this conclusion must be check by continuous CCD or photoelectric measures.

Tab.1: observed times of minima of S ANT.

J.d.	E	O-C	Observer	Reference
2435139.929	0	0.000	==	GCVS 1985
2440289.425 V	7942.5	0.016	K.Locher	Orion 14,112
2440290.399 V	7944	0.017	K.Locher	Orion 14,112
2440314.386 V	7981	0.016	K.Locher	Orion 14,112
2440589.616 V	8405.5	0.023	K.Locher	Orion 28,117
2440629.484 V	8467	0.018	K.Locher	Orion 28,117
2440630.464 V	8468.5	0.025	K.Locher	Orion 28,118
2440655.400 V	8507	0.000	K.Locher	Orion 28,118
2440658.337 V	8511.5	0.019	K.Locher	Orion 28,118
2441023.359 V	9074.5	0.023	K.Locher	Orion 29,124
2441070.354 V	9147	0.013	R.Germann	Orion 29,125
2441350.425 V	9579	-0.001	K.Locher	BBSAG Bull 1
2441401.332 V	9657.5	0.011	K.Locher	BBSAG Bull 2
2441728.420 V	10162	0.009	K.Locher	BBSAG Bull 8
2441753.359 V	10200.5	-0.013	R.Germann	BBSAG Bull 8
2441753.369 V	10200.5	-0.003	K.Locher	BBSAG Bull 8
2441764.393 V	10217.5	-0.001	R.Germann	BBSAG Bull 8
2441766.333 V	10220.5	-0.006	R.Germann	BBSAG Bull 8
2441777.350 V	10237.5	-0.011	R.Germann	BBSAG Bull 9
2441777.381 V	10237.5	0.020	K.Locher	BBSAG Bull 9
2441789.377 V	10256	0.022	K.Locher	BBSAG Bull 9
2442052.592 V	10662	0.009	K.Locher	BBSAG Bull 13
2442433.486 V	11249.5	-0.000	K.Locher	BBSAG Bull 20
2442445.496 V	11268	0.015	K.Locher	BBSAG Bull 21
2442446.477 V	11269.5	0.024	K.Locher	BBSAG Bull 21
2442458.434 V	11288	-0.013	K.Locher	BBSAG Bull 21
2442838.387 V	11874	0.009	K.Locher	BBSAG Bull 26
2446514.488 V	17544	-0.006	J.Schmidt	BAV Mitt 46
2446514.494 V	17544	0.000	A.Thomas	BAV Mitt 46
2446515.451 V	17545.5	-0.015	J.Schmidt	BAV Mitt 46
2446515.462 V	17545.5	-0.004	A.Thomas	BAV Mitt 46
2446516.419 V	17547	-0.020	A.Thomas	BAV Mitt 46
2446516.420 V	17547	-0.019	J.Schmidt	BAV Mitt 46
2449783.460 V	22586	0.010	M.Martignoni	BBSAG Bull 110
2449797.419 V	22607.5	0.031	M.Martignoni	BBSAG Bull 110
2449798.409 V	22609	0.048	M.Martignoni	**
2449799.363 V	22610.5	0.029	M.Martignoni	**
2449810.388 V	22627.5	0.032	M.Martignoni	**

(**) observations submitted to the BBSAG Bull.

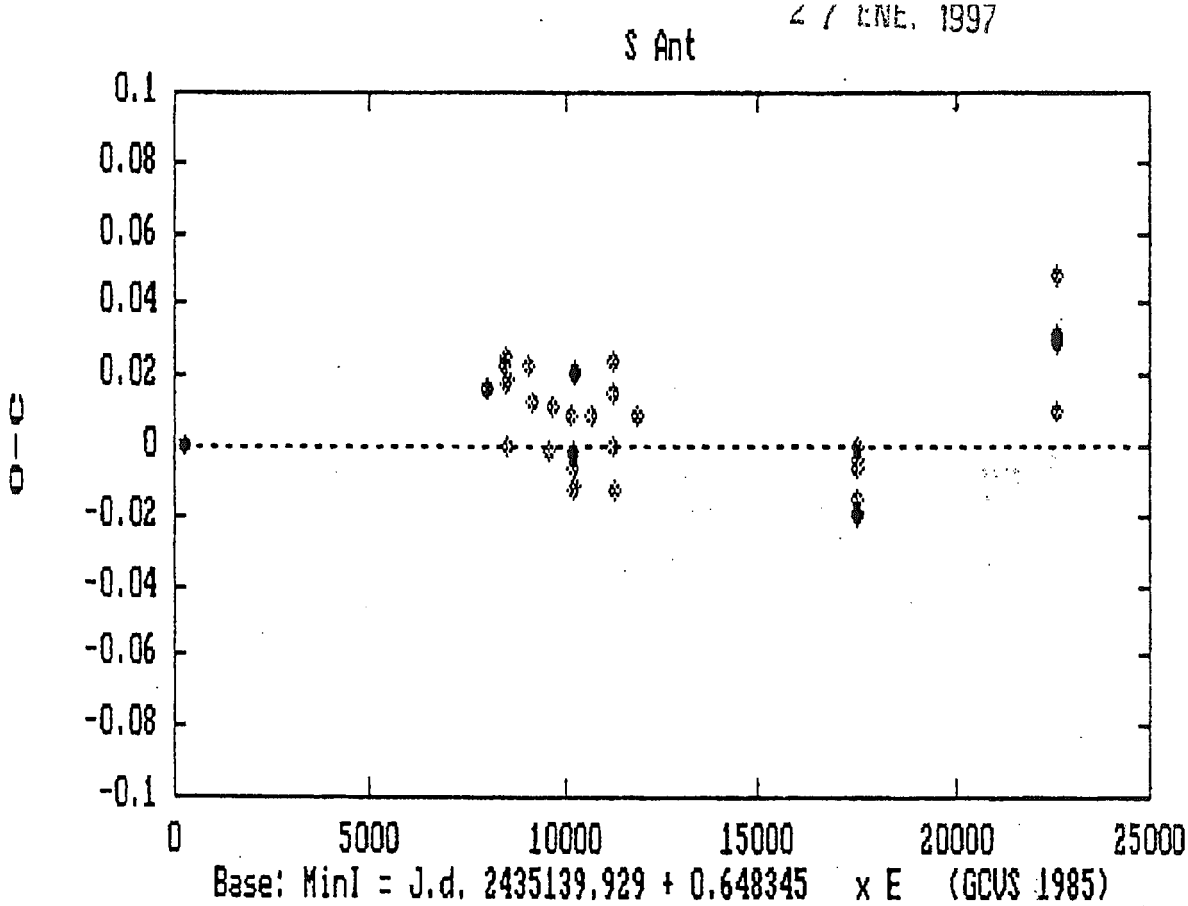
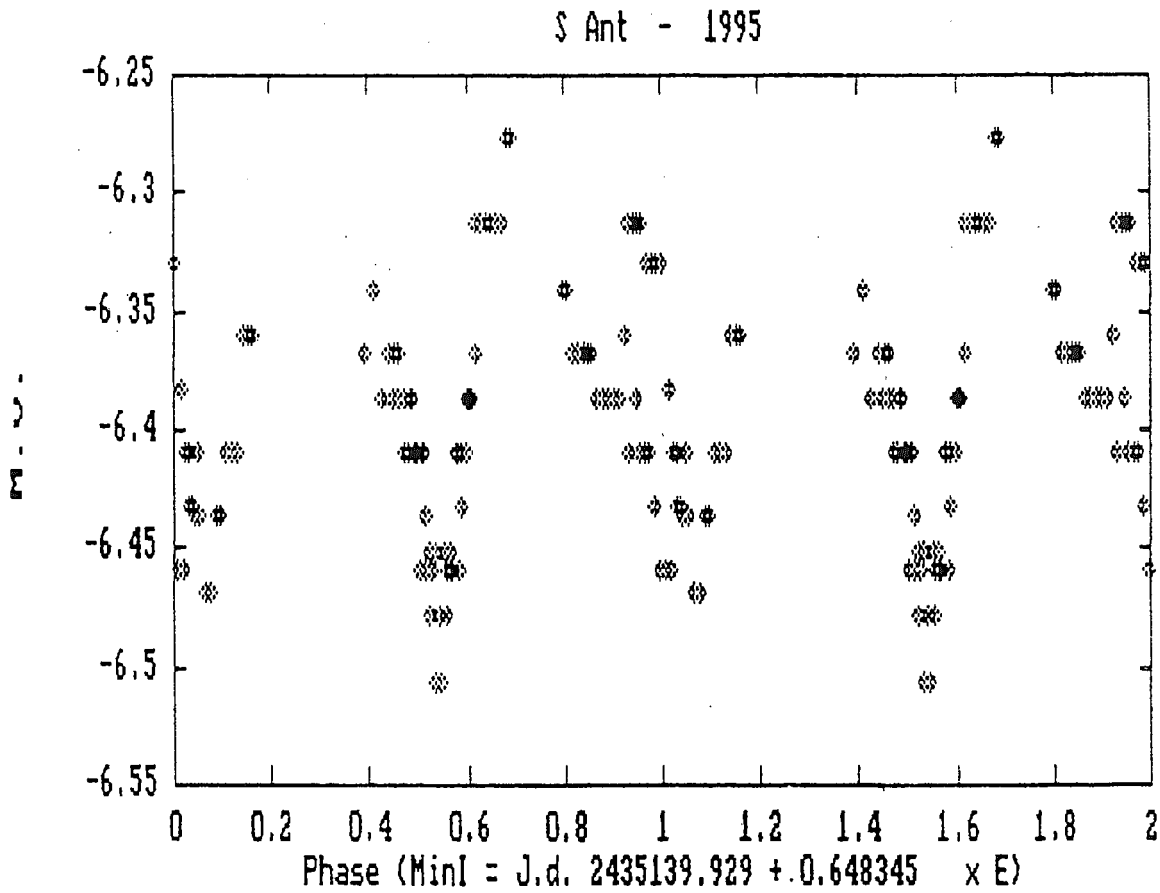


Fig.1: O-C diagram of S ANT.

Fig.2: 1995 visual light curve.



2) EH CNC

The EW type eclipsing binary EH CNC is located in the constellation of Cancer with 1950.0 coordinates: A.R. = 8h 23m 24s, Decl. = +21° 2',7 and a range of variation between V band magnitudes 11.73 and 12.47.
According to Kholopov et al. (NSV, 1982) the spectral type is F0.
It was discovered as suspected variable in 1934 by P.G.Kulikovskij (P.Z. 4, 294,1934) but it was finally classified as variable stars after photoelectric measures performed by A.Figer et al. (I.B.V.S. 2755,1985); they gave also the first known ephemeris:

Min.I = J.d. 2445768.624 + 0.418034 x E (1)

Previous visual estimations made by Figer and other observers member of the GEOS were used already to confirm the variation and to determine a preliminary ephemerides (GEOS NC 387,1984).
Since that time few minima on EH CNC have been published mainly on BBSAG Bull.
After visual observations carried out in 1995, I noted that the elements, quoted above, are valid no more.
Using my times of minima together with other timings found in literature, (see tab.2) I am able to derive the following new improved elements:

Min.I = J.d. 2445768.625 + 0.4180364 x E (2)
+/- 3 +/- 4

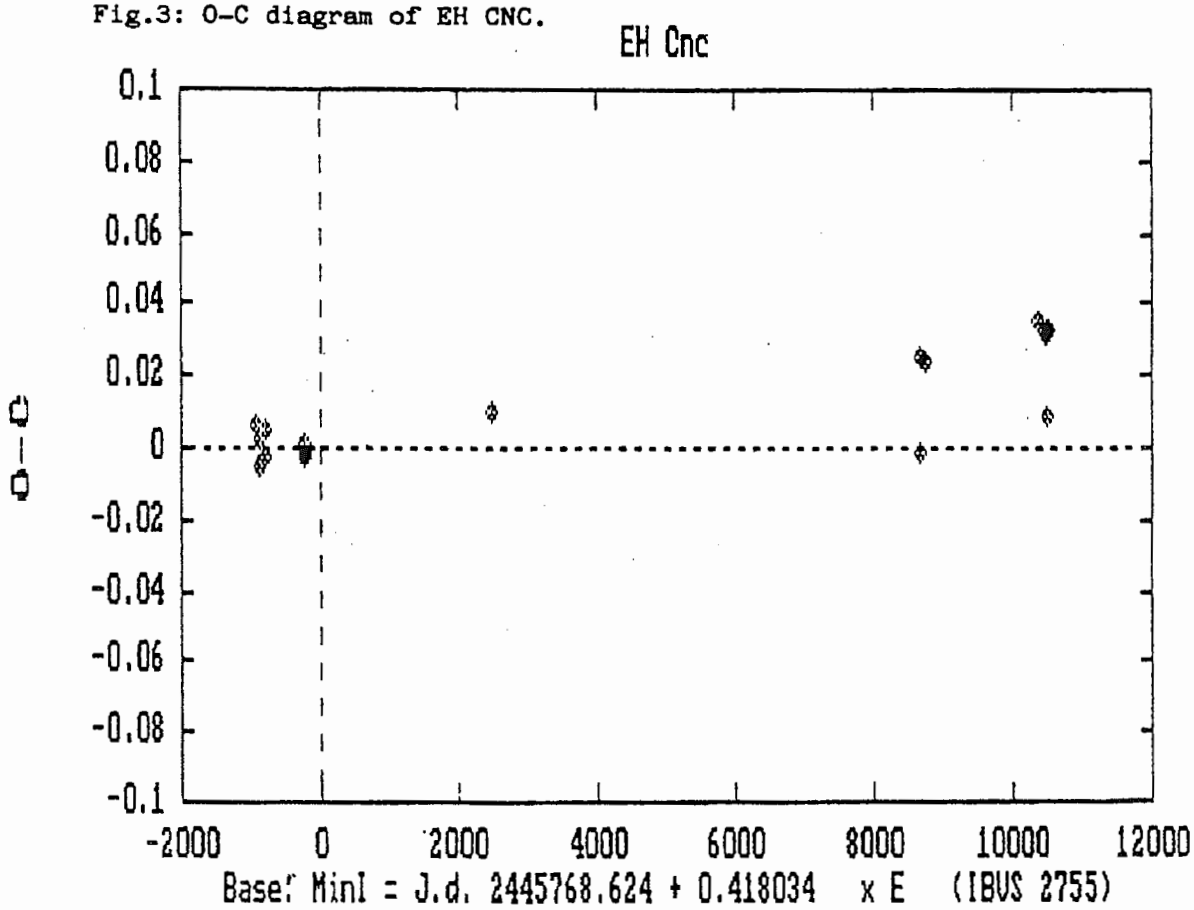
Further observations are needed in order to confirm these light elements, as they are based mainly on visual data; however the trend of the O-C diagram (Fig.3) seems to show clearly that the period found by Figer et al. is not adequate for the present time.
The new elements quoted above seem to fit better the points in the O-C diagram giving smaller residuals.

A summary of this work has been submitted to the BBSAG Bull.

Tab.2: observed times of minima of EH CNC.

J.d.		E (1)	O-C (1)	E (2)	O-C (2)	Observer(s)	Reference
2445385.502	v	-916.5	0.006	-916.5	0.007	A.Figer	GEOS NC 367
2445399.495	v	-883	-0.005	-883	-0.004	A.Figer	GEOS NC 367
2445402.429	v	-876	0.003	-876	0.004	A.Figer	GEOS NC 367
2445410.365	v	-857	-0.004	-857	-0.003	A.Figer	GEOS NC 367
2445438.382	v	-790	0.005	-790	0.006	A.Figer	GEOS NC 367
2445440.465	v	-785	-0.002	-785	-0.001	A.Figer	GEOS NC 367
2445672.6838	V	-229.5	-0.0014	-229.5	-0.0018	A.Figer et al.	IBVS 2755
2445675.6123	V	-222.5	0.0009	-222.5	0.0004	A.Figer et al.	IBVS 2755
2445676.6545	V	-220	-0.0020	-220	-0.0025	A.Figer et al.	IBVS 2755
2446800.342	v	2468	0.010	2468	0.003	A.Maraziti	BBSAG Bull 85
2449393.422	v	8671	0.025	8671	0.003	M.Martignoni	BBSAG Bull 107
2449394.441	v	8673.5	-0.001	8673.5	-0.023	M.Martignoni	BBSAG Bull 107
2449429.372	v	8757	0.024	8757	0.002	M.Martignoni	BBSAG Bull 107
2450097.401	v	10355	0.035	10355	0.009	J.Vandenbroere	BBSAG Bull 112
2450151.533	v	10484.5	0.032	10484.5	0.005	A.Dedoch	BBSAG Bull 112
2450152.346	v	10486.5	0.009	10486.5	-0.018	J.Vandenbroere	BBSAG Bull 112
2450153.416	v	10489	0.033	10489	0.007	J.Vandenbroere	BBSAG Bull 112
2450157.386	v	10498.5	0.0321	10498.5	0.0059	A.Dedoch	BBSAG Bull 112
2450163.448	v	10513	0.033	10513	0.006	A.Dedoch	BBSAG Bull 112

Fig.3: O-C diagram of EH CNC.



3) V417 AQL

The variable star V417 AQL is member of the EW/KW: sub-class of eclipsing binaries according to the GCVS (Kholopov et al., 1985).
It was discovery by Hoffmeister (Astron.Nachr. 255,403,1935) and first investigated by Soloviev (Tadjik Obs.Circ. 22,1,1937 and P.Z. 6,287,1948) who give the photographic light curve together with a list of minima and the light elements as follows:

Min.I = J.d. 2428427.127 + 0.3701207 x E

Further studies were carried out by Koch (A.J. 61,47,1956) who found a range of variation between photographic magnitudes 11.0 and 11.5 with primary and secondary minima equally deep.
The light elements given by Koch are quoted in the Finding List for Observers of Interacting Binary Stars (Wood et al., 1980):

Min.I = J.d. 2428427.127 + 0.3701251 x E

Since that time only few data has been published on V417 AQL, with the exception of the photoelectric measures of Faulkner (IBVS 2439, 1983) and Agerer (BAV Mitt 50), some visual and CCD minima observed by BAV and BBSAG members and new light elements by Kholopov et al. (GCVS, 1985):

Min.I = J.d. 2443016.404 + 0.3701288 x E (1)

From my 1995 visual observations I was able to calculate two times of minima listed in Tab.3 and, using recent minima found in literature, to derive these new light elements:

Min.I = J.d. 2443016.417 + 0.3701238 d x E (2)
+/- 5 +/- 4

They are valid since J.d. 2.442.990.
Taking into consideration old minima also (before J.d. 2.441.135) I had not success in searching for a relationship describing the change of the period of V417 AQL (Fig.4 and Fig.5), so I suggest a abrupt change between J.d. 2.441.135 and 2.442.900; these limits could be not precise because they are based on visual observations.
The light elements published recently by Pauley et al. (IBVS 4358,1996), valid for the time after J.d. 2.433.000, seem to fit well only minima after J.d. 2.448.500.

Tab.3: observed times of minima of V417 AQL.

J.d.		E (1)	O-C (1)	E (2)	O-C (2)	Observer	Reference
2428823.156	V	-38347	0.081	-38347	-0.123	A.V.Soloviev	PZ 6,287
2441135.405	V	-5082	-0.004	-5082	-0.043	R.Diethelm	Orion 29,142
2442990.498	V	-70	0.003	-70	-0.011	R.Diethelm	BBSAG Bull 29
2443016.414	V	0	0.010	-0	-0.003	R.Diethelm	BBSAG Bull 29
2443765.379	V	2023.5	0.019	2023.5	0.016	R.Diethelm	BBSAG Bull 39
2444476.350	V	3944.5	-0.027	3944.5	-0.021	R.Diethelm	BBSAG Bull 49
2444486.367	V	3971.5	-0.004	3971.5	0.003	R.Diethelm	BBSAG Bull 50
2444815.397	PE	4860.5	-0.018	4860.5	-0.007	R.Diethelm	BBSAG Bull 56
2444852.430	V	4960.5	0.002	4960.5	0.014	E.Heiser	BAV Mitt 34
2445196.447	V	5890	-0.015	5890	0.001	M.Fernandes	BAV Mitt 36
2445225.350	PE	5968	0.017	5968	0.034	M.Hoffmann	IBVS 2344
2445542.689	PE	6825.5	-0.029	6825.5	-0.008	D.R.Faulkner	IBVS 2439
2445550.651	PE	6847	-0.025	6847	-0.004	D.R.Faulkner	IBVS 2439
2445554.723	PE	6858	-0.024	6858	-0.003	D.R.Faulkner	IBVS 2439
2445558.438	V	6868	-0.011	6868	0.010	H.Zimmermann	BAV Mitt 38
2445575.647	PE	6914.5	-0.013	6914.5	0.008	D.R.Faulkner	IBVS 2439
2445605.642	PE	6995.5	0.002	6995.5	0.023	D.R.Faulkner	IBVS 2439
2445892.447	PE	7770.5	-0.043	7770.5	-0.017	R.Diethelm	BBSAG Bull 73
2445935.404	PE	7886.5	-0.021	7886.5	0.005	F.Agerer	BAV Mitt 39
2445945.399	V	7913.5	-0.019	7913.5	0.007	P.Frank	BAV Mitt 39
2445962.622	PE	7960	-0.007	7960	0.019	D.R.Faulkner	PASP 98
2446676.379	V	9888.5	-0.044	9888.5	-0.008	A.Paschke	BBSAG Bull 81
2446679.347	V	9896.5	-0.037	9896.5	-0.001	A.Paschke	BAV Mitt 46
2446696.390	V	9942.5	-0.020	9942.5	0.017	A.Paschke	BBSAG Bull 82
2446702.311	V	9958.5	-0.021	9958.5	0.016	A.Paschke	BBSAG Bull 82
2446977.454	PE	10702	-0.068	10702	-0.028	F.Agerer	BAV Mitt 50
2446982.456	PE	10715.5	-0.063	10715.5	-0.022	F.Agerer	BAV Mitt 50
2447407.397	V	11863.5	-0.030	11863.5	0.016	A.Paschke	BBSAG Bull 89
2447412.397	V	11877	-0.027	11877	0.019	A.Paschke	BBSAG Bull 89
2447432.386	V	11931	-0.025	11931	0.021	A.Paschke	BBSAG Bull 90
2448163.382	CCD	13906	-0.033	13906	0.023	A.Paschke	BBSAG Bull 96
2448448.522	PE	14676.5	-0.078	14676.5	-0.018	F.Agerer	BAV Mitt 60
2448476.490	PE	14752	-0.054	14752	0.006	F.Agerer	BAV Mitt 60
2448490.365	CCD	14789.5	-0.059	14789.5	0.002	A.Paschke	BBSAG Bull 99
2448500.366	PE	14816.5	-0.051	14816.5	0.009	F.Agerer	BAV Mitt 60
2448843.460	CCD	15743.5	-0.067	15743.5	-0.002	A.Paschke	BBSAG Bull 102
2449546.498	PE	17643	-0.089	17643	-0.014	F.Agerer	BAV Mitt 80
2449568.531	PE	17702.5	-0.078	17702.5	-0.003	F.Agerer	BAV Mitt 80
2449571.495	CCD	17710.5	-0.075	17710.5	-0.000	A.Paschke	BBSAG Bull 108
2449917.920	PE	18646.5	-0.091	18646.5	-0.011	B.Pauley et al.	IBVS 4358
2449918.845	PE	18649	-0.091	18649	-0.011	B.Pauley et al.	IBVS 4358
2449919.956	PE	18652	-0.090	18652	-0.010	B.Pauley et al.	IBVS 4358
2449920.696	PE	18654	-0.090	18654	-0.011	B.Pauley et al.	IBVS 4358
2449920.883	PE	18654.5	-0.089	18654.5	-0.009	B.Pauley et al.	IBVS 4358
2449921.808	PE	18657	-0.089	18657	-0.009	B.Pauley et al.	IBVS 4358
2449922.918	PE	18660	-0.089	18660	-0.009	B.Pauley et al.	IBVS 4358
2449959.382	V	18758.5	-0.083	18758.5	-0.003	M.Martignoni	**
2449962.361	V	18766.5	-0.065	18766.5	0.015	M.Martignoni	**

(**) observations submitted to the BBSAG Bull.

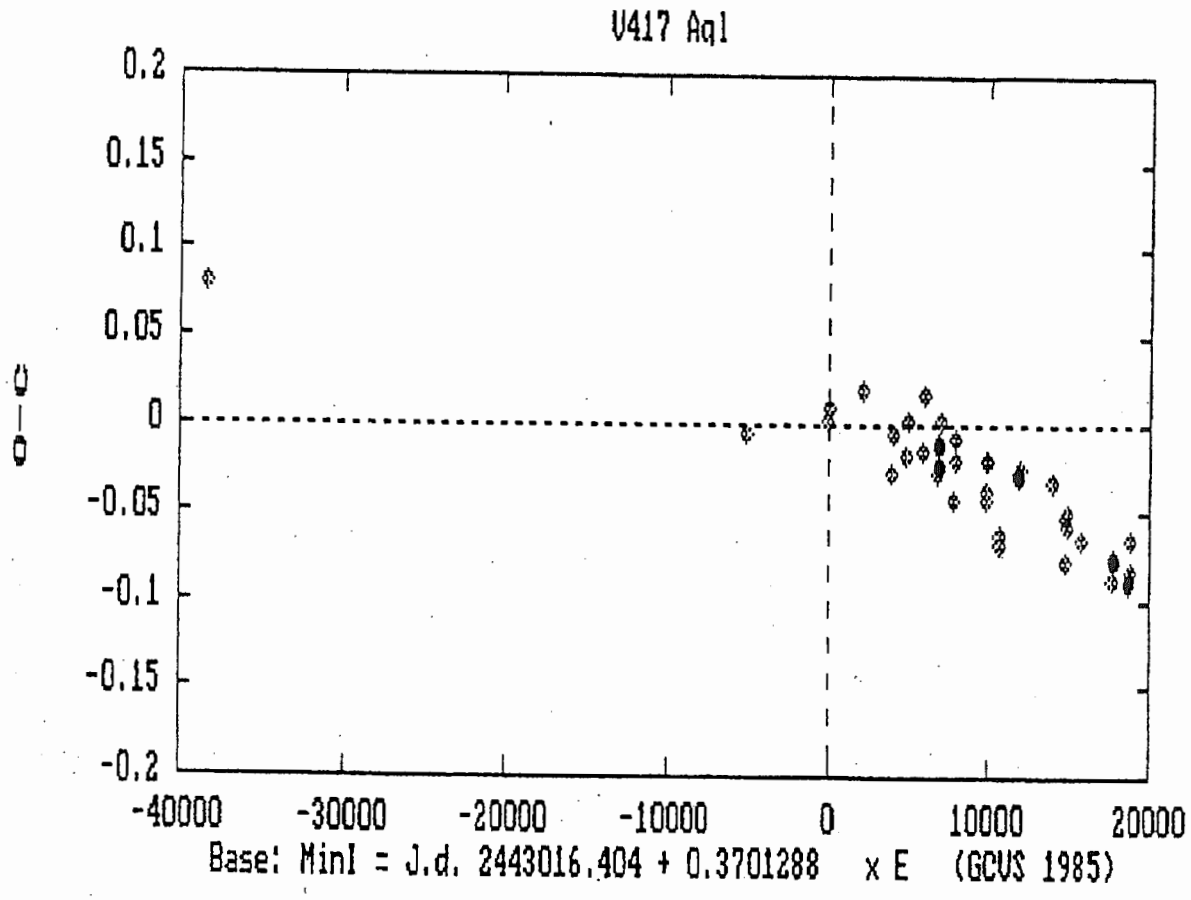
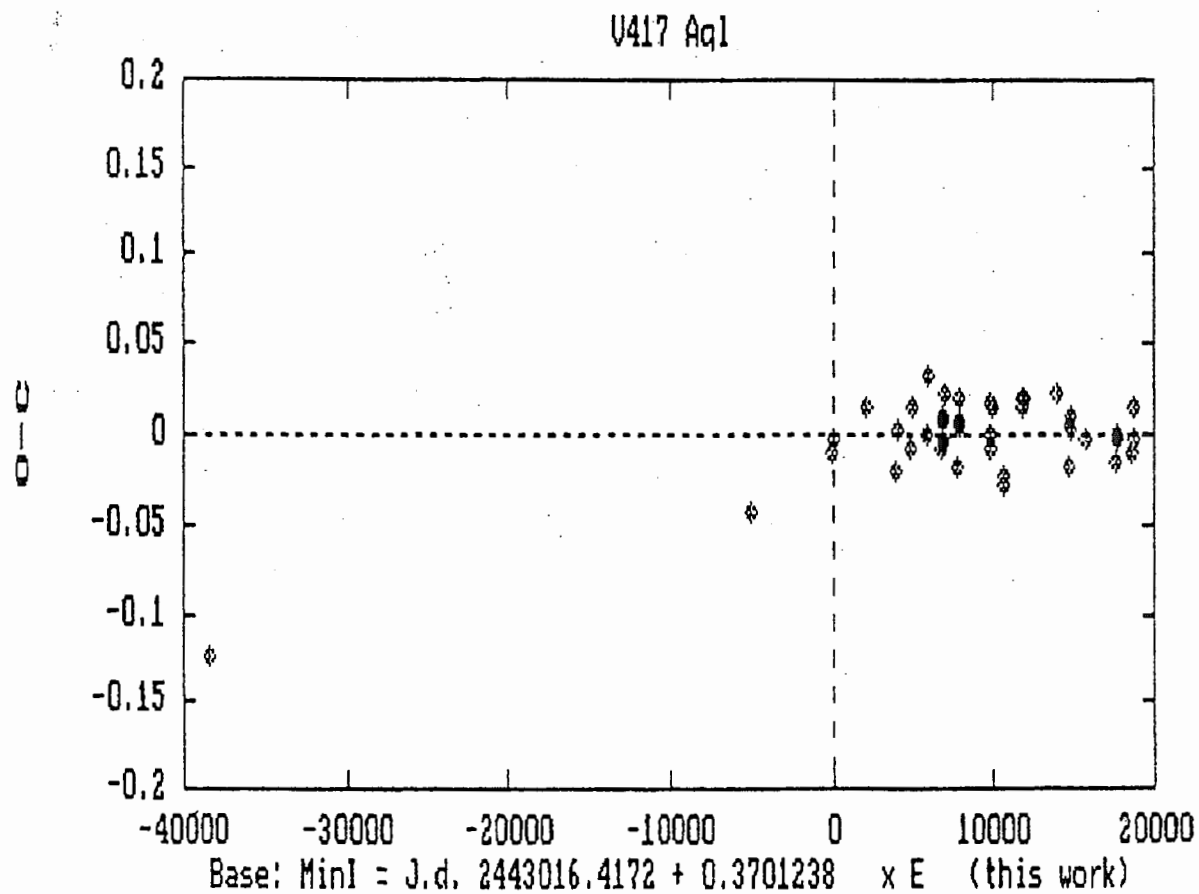


Fig.4: O-C diagram according to the light elements listed in the GCVS 1985.

Fig.5: O-C diagram according to the new light elements.



4) EX DEL

EX Del is an eclipsing binary of the EW/KW sub-class varing between photographic magnitudes 12.8 and 13.3. The spectral type is unknown.
This object was discovered by Hoffmeister (Erg.Astron.Nachr. 12,1,1949), but without clear indication of the type of variability; the W UMa class was first detected by Karamysh and Mandel (Variable Star 15,586,1965) who also published a photographic light curve and a long list of minima.
On the basis of these observations they were able to give the following ephemerides:

Min.I = J.d. 2429846.372 + 0.39684486 x E

and these elements are currently quoted in the G.C.V.S. (Kholopov et al., 1985).
A further work based on photoelectric data published by Hoffmann and Meinunger (IBVS 2343, 1983) points out the erroneus determination of the above period of variation: 33 minima observed until J.d. 2.445.209 were used to determine new light elements as follow:

Min.I = J.d. 24338.343 + 0.3309882 d x E (1)

I suspect that in these light elements two digit of the epoch are omitted because Hoffmann and Meinunger reported new ephemeris for three variable stars: for the other two objects the epoch is given with the 7 digit Julian Day.
Further times of minima are available on the Bulletin of the BBSAG, mainly coming from CCD observations of Paschke.
From my 1996 visual estimations I was able to obtain 6 new minima showing the times of them about 2 hours before the ephemerides of Hoffmann and Meinunger.
Using these minima together with other ones found in the recent literature (Tab.4), I calculate these new light elements:

Min.I = J.d. 2424338.30 + 0.3309877 x E (2)
+/- 2 +/- 3

I don't take into consideration minima published before J.d. 2.445.000 as they present a systematic error because forced to be accorded to the light elements published by Karamysh and Mandel.
There is not an indication of period change since J.d. 2.445.000 (Fig.6).

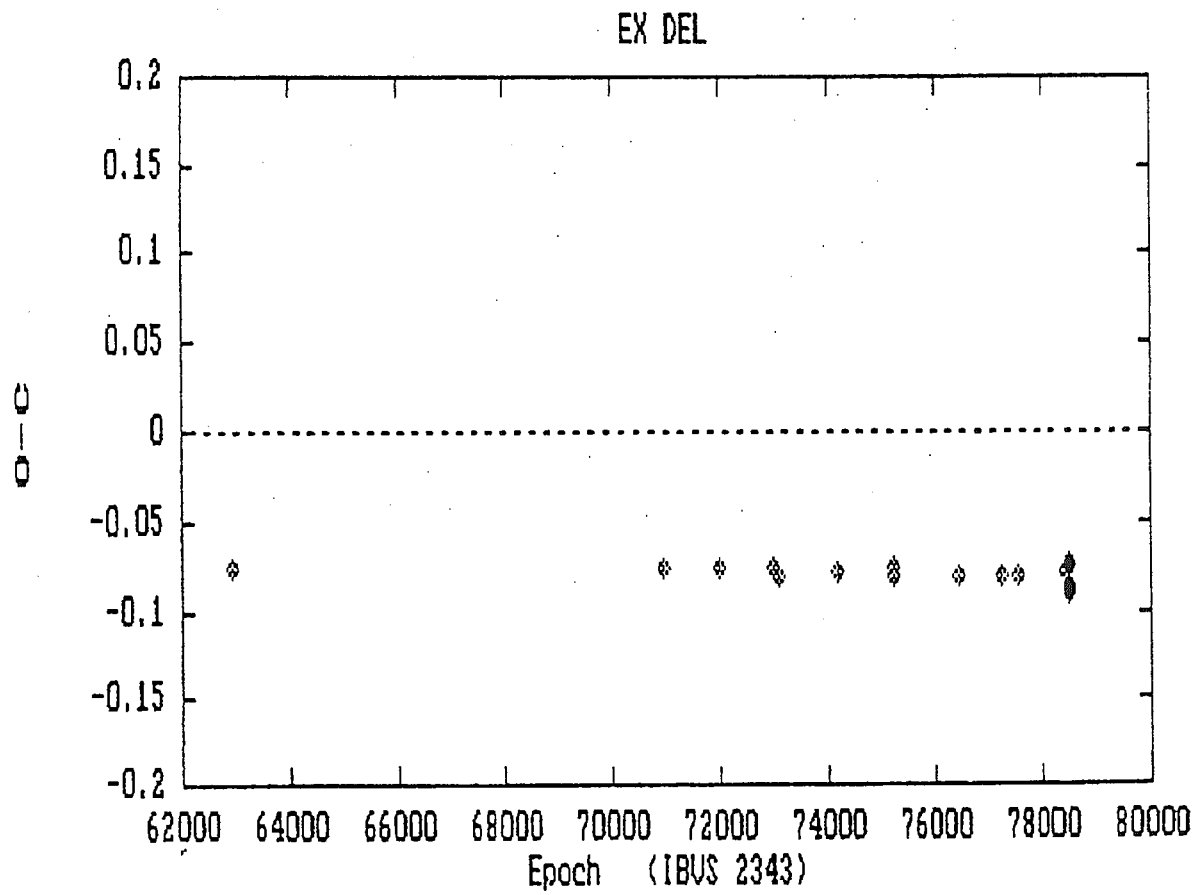
A summary of the present work on EX DEL will be submitted to the BBSAG Bull.

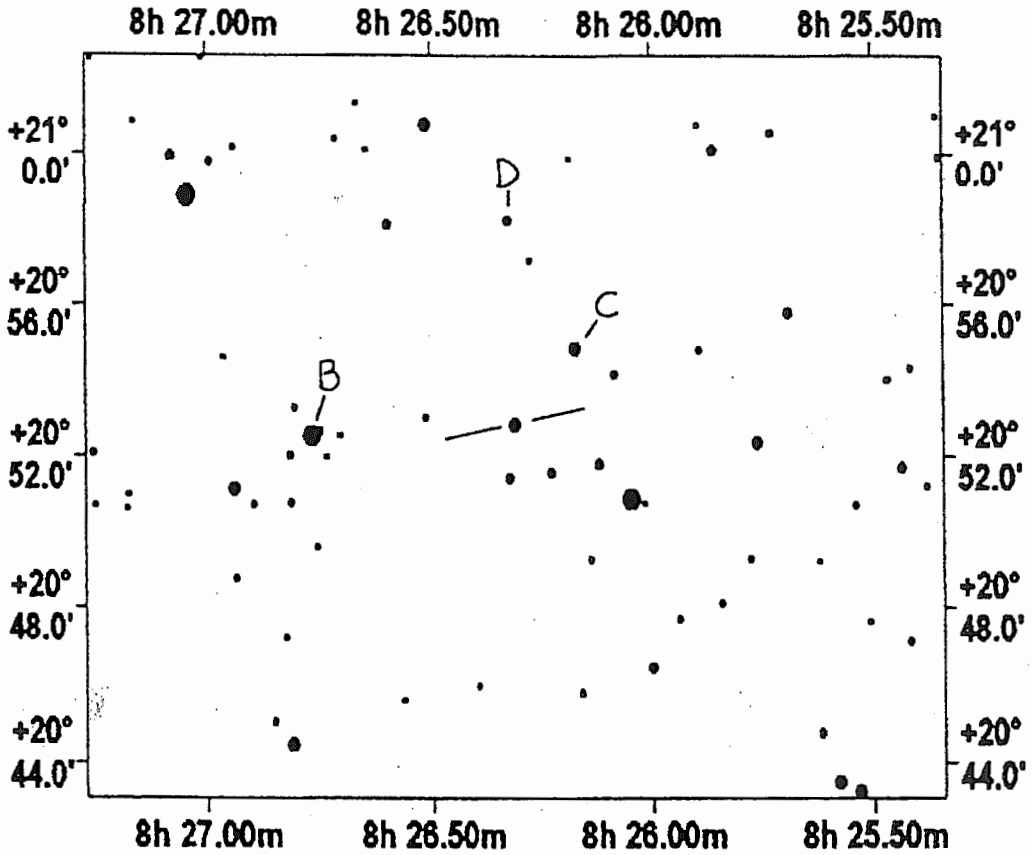
Tab.4: observed times of minima of EX DEL.

J.d.		E (1)	O-C (1)	E (2)	O-C (2)	Observer	Reference
2445166.528	PE	62927.5	-0.075	62927.5	-0.001	M.Hoffmann	IBVS 2344
2447822.375	CCD	70951.5	-0.077	70951.5	0.001	A.Paschke	BBSAG Bull 95
2448170.410	CCD	72003	-0.076	72003	0.003	A.Paschke	BBSAG Bull 97
2448504.378	CCD	73012	-0.075	73012	0.004	A.Paschke	BBSAG Bull 100
2448534.328	CCD	73102.5	-0.080	73102.5	-0.000	A.Paschke	BBSAG Bull 100
2448883.357	CCD	74157	-0.078	74157	0.002	A.Paschke	BBSAG Bull 102
2449236.358	CCD	75223.5	-0.076	75223.5	0.005	A.Paschke	BBSAG Bull 105
2449236.517	CCD	75224	-0.082	75224	-0.002	A.Paschke	BBSAG Bull 105
2449641.318	CCD	76447	-0.080	76447	0.001	A.Paschke	BBSAG Bull 109
2449906.438	CCD	77248	-0.082	77248	0.000	A.Paschke	BBSAG Bull 111
2450004.410	CCD	77544	-0.082	77544	-0.000	A.Paschke	BBSAG Bull 111
2450287.573	CCD	78399.5	-0.079	78399.5	0.003	E.Blaettler	BBSAG Bull 112
2450312.401	v	78474.5	-0.075	78474.5	0.007	M.Martignoni	**
2450313.396	v	78477.5	-0.073	78477.5	0.009	M.Martignoni	**
2450318.357	v	78492.5	-0.077	78492.5	0.005	M.Martignoni	**
2450318.512	v	78493	-0.088	78493	-0.006	M.Martignoni	**
2450319.342	v	78495.5	-0.085	78495.5	-0.003	M.Martignoni	**
2450319.503	v	78496	-0.090	78496	-0.008	M.Martignoni	**

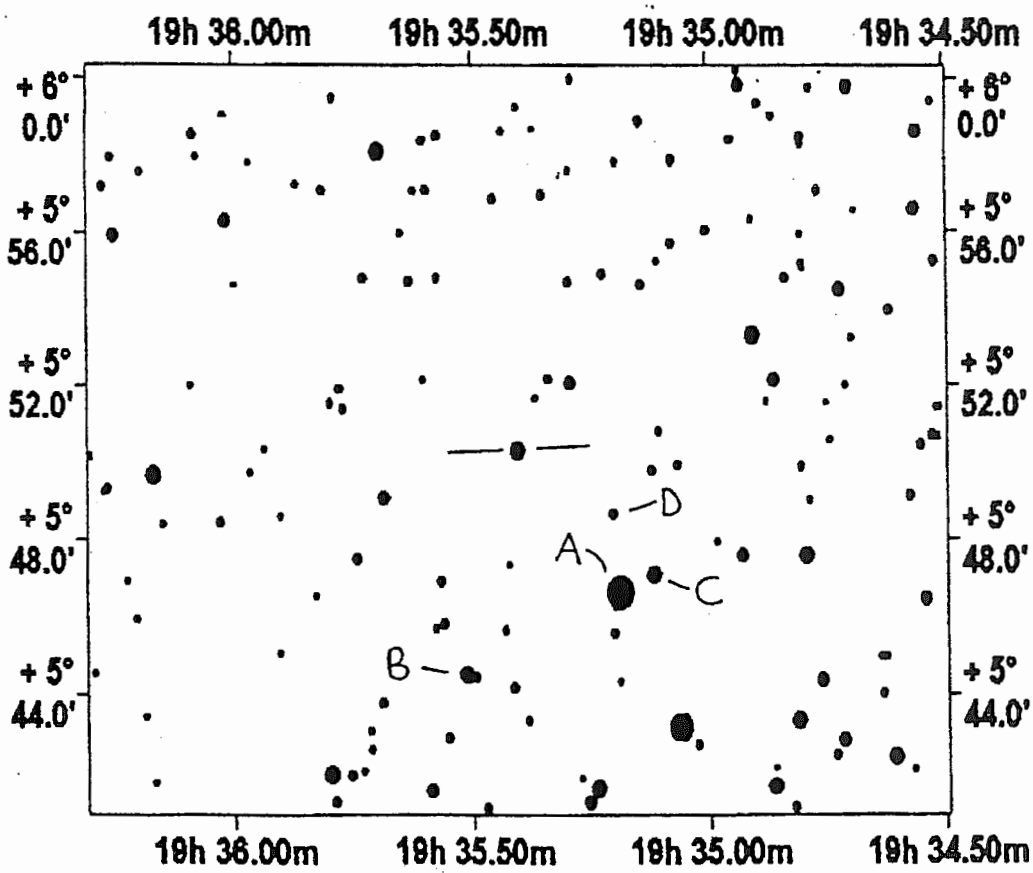
(**) observations submitted to the BBSAG Bull.

Fig.6: O-C diagram of EX DEL.

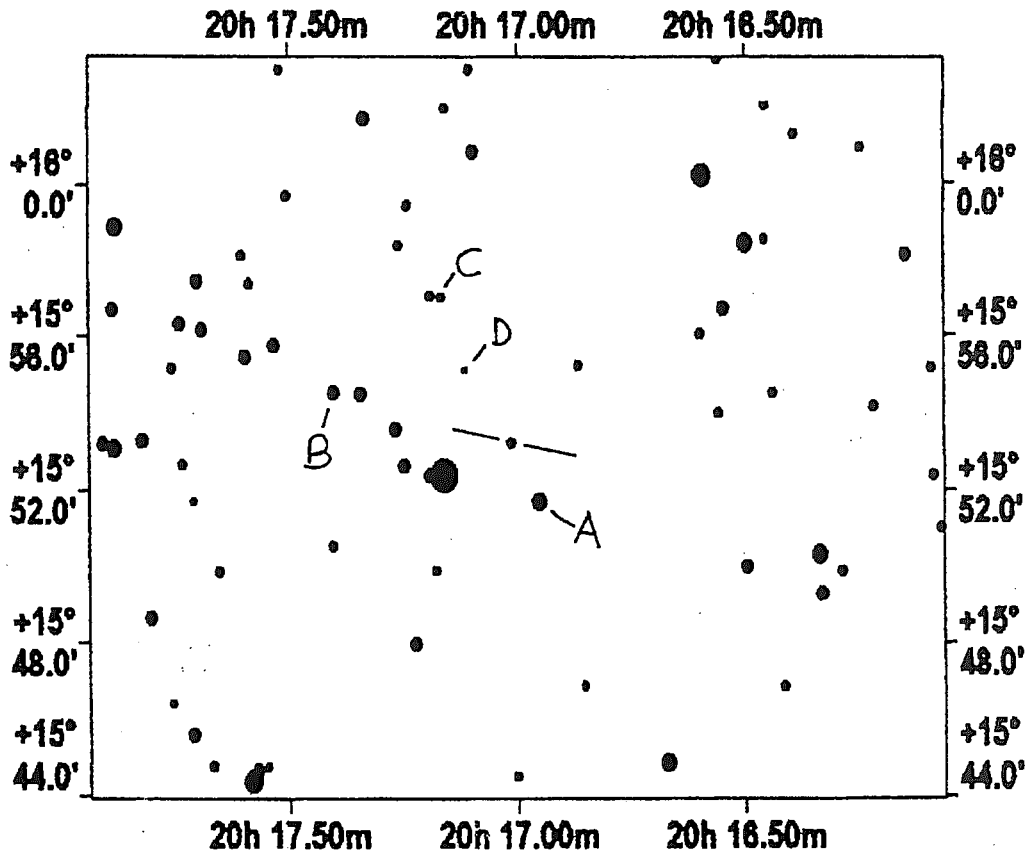




EH CNC



V417 AQL



EX DEL

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