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N° 123

RÉDACTEUR EN CHEF

P. M. DJURKOVIĆ

BEOGRAD 1970

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Page	Colonne	Ligne	au lieu de	lire
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5	1	2 "	grouped into three columns within each Table. The left column indicates measurements immediately before flare, the mid one during flare and the right one after flare.	they should be grouped as folows: Numbers 1-12 in Table 2, 1-9 in Table 4 correspond to the measurements before flare. Numbers 13-22 in Table 3 and 6-9 in Table 4 correspond to the measurements during flare. Numbers 23-34 in Table 2, 14-20 in Table 4 correspond to the measurements after flare.
5	2	au dessous des figures		Fig. 2. Fig. 3. Fig. 4.
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L'OBSERVATOIRE ASTRONOMIQUE DE BEOGRAD

ANNEE 1968-1969 F. 1 VOLUME XXVIII

AN ATTEMPT TO ANALYSE THE FLARE POLARIZATION OF SOME UV CETI STARS

A. Kubičela and J. Arsenijević

At the end of 1965 and in the course of 1966 at Belgrade Observatory regular patrol observations of UV Ceti stars were done with the aim to establish eventual changes of polarization paramaters during flares. The main motive for this observational programme was a general need to find out and to be acknowledged with the polarimetric aspect of the physical processes which take place on these stars. The remark put by Oskanjan (1964) on a possible increase of degree of polarization during a flare of AD Leo, was just the reason to adhere to this problem, and its importance was stressed by Greenstein (1960) at a polarimetric meeting in USA.

The observations were done by the Belgrade Astronomical Observatory polarimeter (Oskanjan et al 1965.). The polarimeter was used in combination with the refractor Zeiss 65/1055 cm. Characteristics of polarimeter, continuous recording of the polarimetric signal at one channel and simultaneous recording of the signal, corresponding to the observed intergrated radiation flux of the star at the other channel, enabled us to analyse, with good time resolution, polarization changes during the three observed flares.

The observations

Intervals of time covered by the patrol observations are represented in the Table 1. The column "Observer" in the Table, contains the following symbols : A = Arsenijević, K = Kubičela. For all that time ($4187^m = 69^h47^m$ of the effective observations) four smaller increases of brightness were observed:

1) On the star EQ Peg, 24.10.65 at $21^h 00^m$ TU the increase with amplitude of 0,45 magnitude, Fig. 1, A.

2) On the star EQ Peg, 2.11.65. at $23^h 43^m$ TU the increase with amplitude of 0,35 magnitude, Fig. 1, B.

3) On the star EQ Peg, 6.11.65. at $17^h 34^m$ TU the increase with amplitude of 0,33 magnitude, Fig. 1, C.

4) On the star AD Leo, 28.02.66 at $20^h 38^m$ TU the increase with amplitude of 0,20 magnitude, Fig. 1, D.

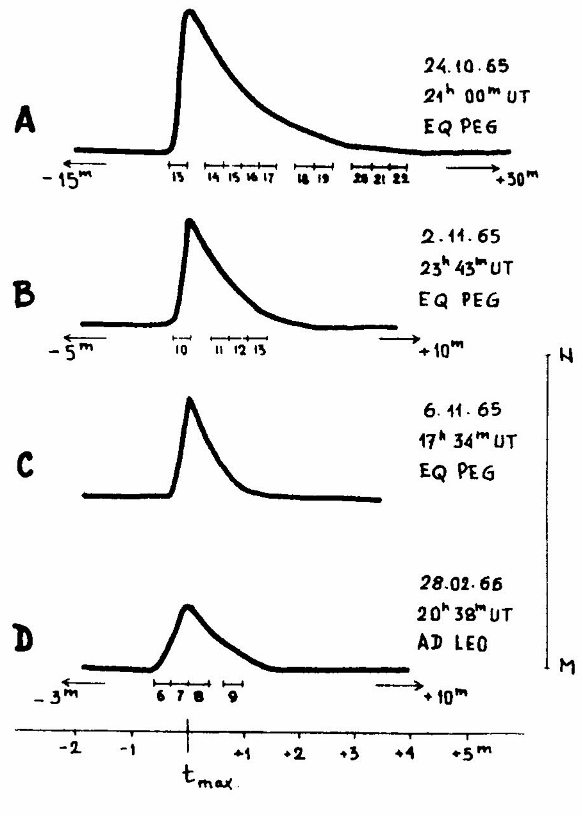
TABLE 1

Stars	Date	Observer	Time of observat. UT				
			Begin.		End		Duration
			h	m	h	m	m
	22.10.66	A, K	19	20	19	52	32
			21	13	22	53	100
			23	04	23	54	50
UV Ceti	4.12.66	A, K	19	45	20	14	29
V371 Ori	24.11.66	A	23	16	24	20	64
	16.12.66	A	24	15	25	15	60
AD Leo	14.02.66	A, K	18	28	18	42	14
	16.02.66	A, K	18	10	21	12	182
			22	18	26	50	272
	20.02.66	A, K	18	48	19	18	30
			19	37	20	34	57
	26.02.66	A, K	21	45	23	34	109
			24	10	26	20	130
	28.02.66	K	18	00	21	02	182
	14.04.66	A, K	23	16	24	16	60
	18.04.66	A, K	21	25	23	45	140
$+51^o2402$	10.10.66	A, K	19	20	20	58	98
DO Cep	24.12.66	K	17	52	18	56	64
EV Lac	6.11.65	K	20	22	23	22	180
	20.11.65	A, K	17	23	18	58	95
	2.11.66	A, K	20	43	22	00	77
	4.11.66	K	19	15	21	00	105
	8.11.66	A	20	32	23	00	148
	26.11.66	A, K	17	20	17	38	18
			18	30	19	30	60
	4.12.66	A, K	16	47	16	55	8
			17	44	18	10	26
			18	19	18	30	11
EQ Peg	18.10.65	A, K	19	30	24	00	270
	20.10.65	A, K	20	59	23	29	150
	22.10.65	K	20	20	22	20	120
	24.10.65	K	20	40	21	05	25
			21	27	22	10	43

Stars	Date	Obser-ver	Time of observat. UT		
			Begin.	End	Duration
			h m	h m	m
	26.10.65	A	19 40	21 10	90
			21 20	22 15	55
	28.10.65	A, K	19 30	20 10	40
	2.11.65	A	23 10	23 50	40
	6.11.65	K	17 32	18 17	45
	4.10.66	A, K	21 45	21 58	13
			22 20	24 30	130
			24 41	25 38	57
	6.10.66	A, K	20 05	20 18	13
			20 21	20 30	9
			20 45	21 34	49
			22 01	24 42	161
	8.10.66	A, K	20 36	24 00	204
	16.10.66	A, K	21 55	23 10	75
			23 25	24 03	38
	18.10.66	A, K	21 55	23 04	69
			23 10	24 40	90

Polarimetric data

At that stage of our programme, the analysis of polarimetric record was done only when a change of star brightness was observed. Time survey of the polarimetric measurements in relation to the approximate light curves is given in Fig, 1. Twenty seconds time intervals, during which polarization signal was integrated and one polarimetric measurement obtained, are shown by short lines right under the corresponding light curve and marked with the same ordinal number, as well as the measurements in the Tables 2, 3 and 4. There are no polarimetric data for flare C because it took



place when only the photometric channel of polarimeter was on. All the curves are in the same scale indicated in minutes of time on the abscissa left and right from the common maximum instant, t_{max}. The ordinate scale is defined by the line NM, whose lengeth represents one apparent stellar magnitude. The lower level of the light curves of EQ Peg corresponds to the integrated undisturbed radiation of compoments A and B in the system IDS 23267 NI1923 (Jeffers, 1963) while the basic level for the light curve of AD Leo corresponds to the radiation of unresolved pair 20C 574 AB in the stationary state (Joy, 1960). The time intervals, during which the polarization of radiation has been measured before and after the flares are marked by the number (in minutes) under the left and right end of each light curve.

The polarimetric results are given for each flare separately, in the Tables 2, 3 and 4.

EQ Peg 24.10.65. TABLE 2

N°	P		θ
	%	m	o
1	2.5	0.054	70
2	1.5	0.033	52
3	0.1	0.002	70
4	0.4	0.009	144
5	2.2	0.043	40
6	1.3	0.028	75
7	0.6	0.013	32
8	0.2	0.004	65
9	2.0	0.043	58
10	1.8	0.039	160
11	1.0	0.022	45
12	0.2	0.004	100
13	2.8	0.061	175
14	4.0	0.087	6
15	2.3	0.050	25
16	1.0	0.022	120
17	0.3	0.007	0
18	1.9	0.041	24
19	0.2	0.004	160
20	0.9	0.020	10
21	1.3	0.028	12
22	2.4	0.052	24
23	1.2	0.026	10
24	0.5	0.011	175
25	3.1	0.067	20
26	2.8	0.061	25
27	3.5	0.076	45
28	2.1	0.045	30
29	3.9	0.065	32
30	0.6	0.013	40
31	0.5	0.011	45
32	2.0	0.043	15
33	0.8	0.017	54
34	4.0	0.087	5

Measurements are marked with ordinal numbers and grouped into three columns within each Table. The left column indicates measurements immediately before flare, the mid one during flare and the right one after flare. Other columns are: degree of polarization P, in per cent and stellar magnitude, position angle, Θ, of the plane of vibration defined as in Hall's measurements (1958).

EQ Peg 2.11.65. TABLE 3

N^o	P		Θ
	%	m	o
1	0.3	0.007	140
2	1.8	0.039	10
3	1.3	0.028	4
4	1.7	0.037	8
5	2.7	0.059	8
6	1.7	0.037	14
7	0.7	0.015	40
8	1.7	0.037	15
9	1.5	0.033	12
10	1.2	0.026	128
11	1.8	0.029	15
12	1.0	0.022	48
13	0.9	0.020	30
14	2.5	0.054	20
15	2.2	0.048	15
16	2.3	0.053	165
17	1.5	0.033	15
18	1.4	0.30	6
19	1.5	0.033	54
20	2.1	0.046	50

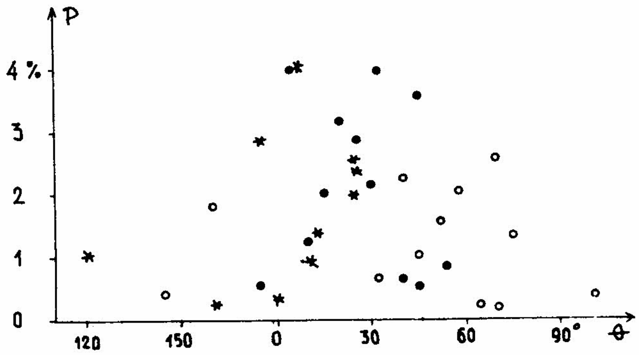
AD Leo 28.02.66 TABLE 4

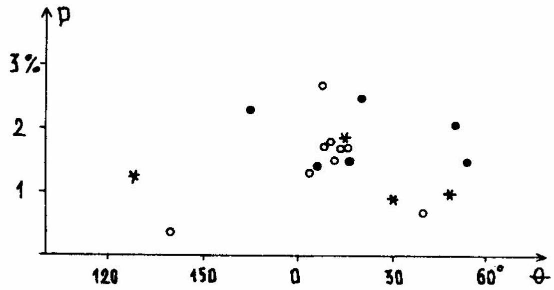
N^o	P		Θ
	%	m	o
1	2.7	0.059	116
2	2.2	0.048	120
3	1.9	0.041	107
4	1.8	0.039	113
5	3.1	0.067	117
6	2.2	0.048	68
7	3.8	0.083	124
8	1.8	0.039	110
9	1.1	0.024	112
10	3.5	0.076	134
11	2.7	0.059	111
12	1.5	0.033	112

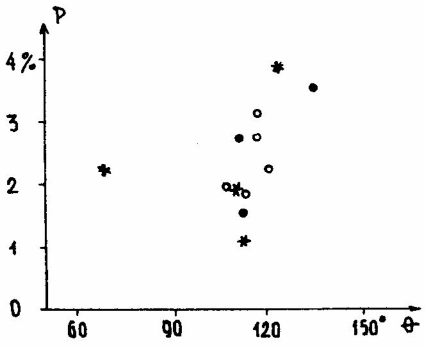
Each single measurement in the Table is the result of comparison done between a sine signal (formed out of 10 measurements of photomultiplier signals at 10 equidistant polaroid positions which covered position angle interval from 0^o to 180^o) with a calibration sine curve whose amplitude is already known, while the position angles of its extreme values are determined in the mentioned Hall's system.

As the data were taken during a flare, the care was paid to the fact that the polarization signal and signal for calibration were recorded at different intensities of the star radiation, so, the polarimetric measurements inside the flare were reduced to the intensity of the star at the instant of observation.

At the reduction of all measurements an additive instrumental sine curve with period of 180^o in position angle, which originates in the optical train of polarimeter was eliminated. Here, however, the depolarizing influence of the objective lens of the refractor, which according to Serkowsky's opinion (1960) was estimated to be about 7 per cent of measured values, was not concerned.







All single measurements from the Tables 2, 3 and 4 are shown graphically in figures 2, 3 and 4 respectively. Here, in POΘ coordinate system (P in per cent, Θ in degrees) each measurement is marked as follows: measurements before flare are open circles, measurements during flare are asterisks and measurements after flare are full circles.

Such a display of polarimetric results is not the right picture of changes of polarization and dispersion of measurements, because the distance between any two points in the figure is not in proportion with the increase of polarization necessary for the transition from one point to another. It concerns specially, points with small degree of polarization. Still, in Figure 2, which contains the most numerous measurements, we can notice different grouping of dots in various phases of observations, what is less striking in the other two figures. So, in spite of the big dispersion of dots (especially at small polarization when measurements of polarization angles have a low weight) in Fig. 2, it is apparently seen that the group of dots representing the measurements done during the flare (asterisks) is shifted towards the smaller position angles in comparision with the group of measurements effected before the flare (open circles). Measurements done in phase after the flare (full circles) take a mid position between the two former measurements, even, we may notice that they are somewhat nearer to the measurements within the flare than to those done before the flare.

Such a grouping cannot be seen in Fig.3, except if we take that the first measurement inside the flare ($P = 1.2\%$, $\Theta = 128^{\circ}$) with its position angle deviates considerably from other measurements, since the position angle of the other deviated dot ($P = 0.3\%$, $\Theta = 140^{\circ}$) is very vague, being determined with a low weight.

In Fig. 4, as in the former case, the measurements are fewer and flare is of the similar amplitude, but the measurements might be more correct due to bigger brightness of the star. Here also, the first from the four measurements during flare, deviates very much with position angle from other measurements. The, highest degree of polarization is apparent, as in the first case, during and after flare.

In the further consideration, so high time resolution (20^{s}) will be given up, and the conclusion will be drawn out of mean measured polarization. First of all, a mean will be taken within the whole group of measurements : before, during and after flare, and then means of each two successive measurements will be taken. By this method we shall achieve a time resolution of several minutes in the first case, or about 40^{s} in the second case. At the same time, the dispersion of observed values will be reduced.

The mean values of polarization $\bar{P}$ (in per cent) and position angle of plane of vibration $\bar{\Theta}$ (in degrees) are given in the Table 5. The mean values were obtained in dependance of the phases of polarimetric signal, on extensive observational material where each measurement of polarization was still represented by a group of ten measurements of photomultiplier signal. Mean value of position angle in plane of vibration obtained in this way, agrees well with mean weight of position angles of corresponding group of measurements in the Tables 2, 3 and 4, if as a weight, a nominal degree of polarization in per cent is taken. Accordingly, to the mean position angles can be attributed the errors carried out by a method for evaluation of errors in measurements of unequal preciseness (Boljšakov, 1965). The other tabulated values are: n-number of measurements used in evaluating of mean values,

σ_0 - r. m. s. error of degree of polarization (in per cent)

σ_1 - r. m. s. error of a single measurement (in per cent),

ν_0 - r. m. s. error of weighted mean position angle of vibration plane (in degrees) and ν_1 = = r. m. s. error of unit weight position angle (in degrees). The columns in the tables represent phases of observations what has been already pointed out by the intervals of ordinal numbers of observations in each column, These numbers correspond to the ordinal numbers in the Tables 2, 3 and 4.

The r. m. s. errors of degree of polarization in each group were determined by taking in consideration only the values of polarimetric signals at one position of the polaroid. The difference between the mean value of this signal for the entire group and every single measurement, treated in the usual way, resulted r. m. s. errors σ_0 and σ_1 in the table.

The mean polarizations from table 5 are indicated in Fig. 5 and 6. A polar coordinate system whose angular argument is a doubled position angle, 2Θ, was applied, and accordingly, each polarimetric data can be represented as an additive vector. The intensity of these vectors is determined by the line $\overline{OP}$ which corresponds to the polarization of 1%. North and south are at the top, the northeast is at the left.

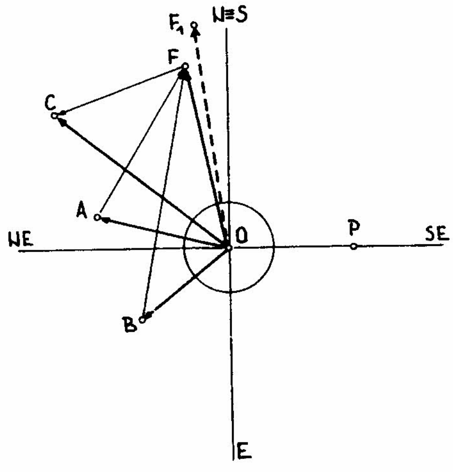
The Fig. 5 contains the measurements carried out on 24. 10. 65. Here we have: $\overrightarrow{OA}$=mean polarization out of 24 measurements before and after flare, $\overrightarrow{OB}$ = mean polarization out of 12 measurements before flare, $\overrightarrow{OC}$ = mean polarization out of 12 measurements after flare, $\overrightarrow{OF}$ = mean polarization out of 10 measurements during flare and

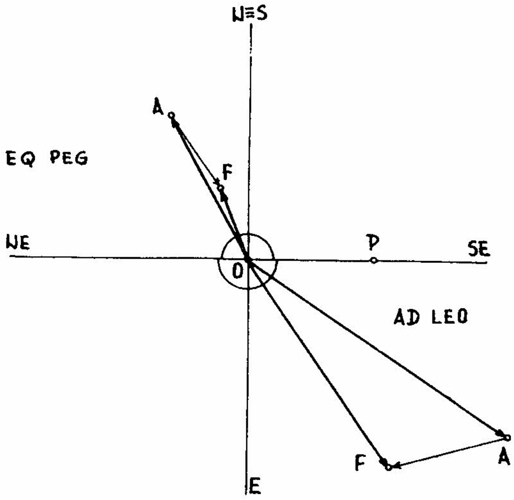
$\overrightarrow{OF_1}$ = mean polarization out of the first 5 measurements inside the flare. Radius of the circle around point O is 0.35% and represents the mean value of r. m. s. error of the mentioned vectors.

The change of mean polarization brought in by the flare is equal to the vecotr $\overrightarrow{AF}$. In this case it amounts to 1,4% in direction of $2\theta = 329^o$. In the second case, if the polarization really deffered before and after flare (what is apparently seen in our observations), the flare has cause the leap of polarization $\overrightarrow{BF}$ with intensity of 2,1% in direction of $2\theta = 350^o$. However, by the change $\overrightarrow{FC}$ in the amount of 1,4% in direction $2\theta = 109^o$ after the flare (in total about 30^m after the flare)the polarization has not returned to its original value $\overrightarrow{OB}$.

T A B L E 5

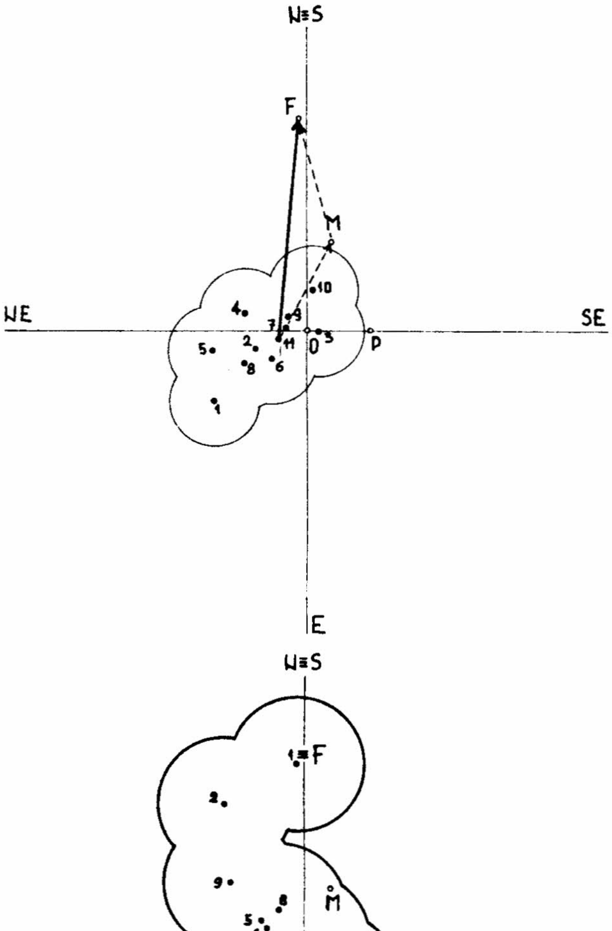
Star	EQ Peg				EQ Peg		AD Leo	
Date	24.10.65.				2.11.65.		28.02.66.	
Phase of the Observation	Out of flare	During flare	Before flare	After flare	Out of flare	During flare	Out of flare	During flare
Sequence of measurements	1-12 23-34	13-22	1-12	23-34	1- 9 14-20	10-13	1- 5 10-12	6- 9
n	24	10	12	12	16	4	8	4
$\bar{P}$	1.1	1.5	0.9	1.7	1.3	0.6	2.5	2.0
δ_0	0.25	0.50	0.30	0.35	0.20	-	0.22	-
δ_1	1.2	1.6	1.0	1.2	0.8	-	0.6	-
$\bar{\theta}$	38	6	65	26	14	11	118	107
v_0	6	4	11	4	5	-	3	-
v_1	34	28	40	20	24	-	14	-

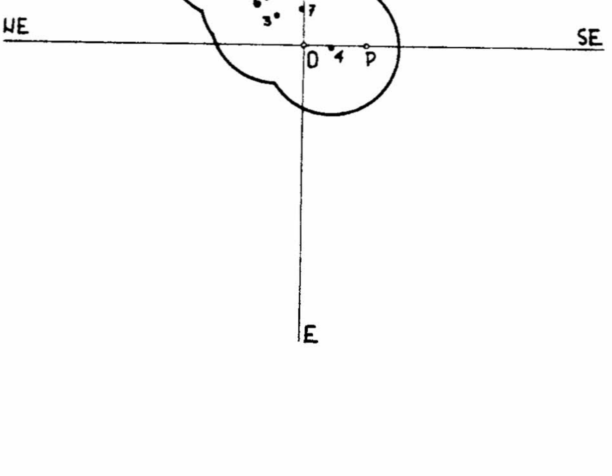




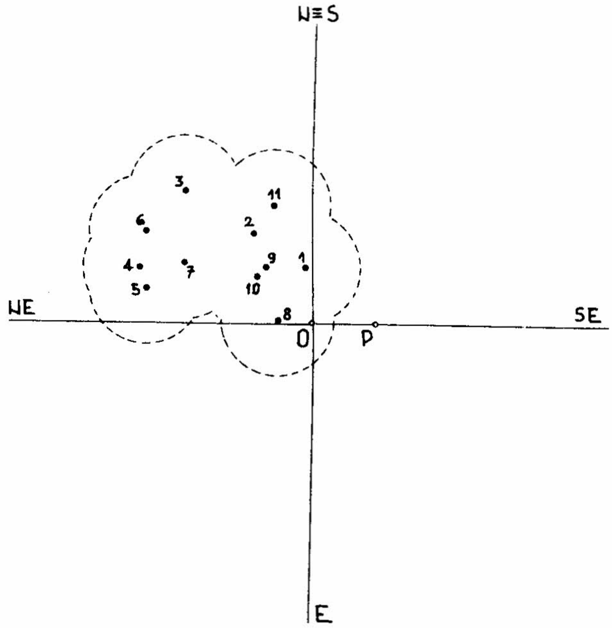
It might be worth of mentioning that mean value of the first five polarimetric measurements inside the flare, vector $\overrightarrow{OF_1}$, in combination with measurements out of flare, increases the change brought in by flare. This effect is more conspicuous when the phenomenon is analysed in detail by taking a mean of the two successive single measurements.

Similarly, and with the same symbols the events of 2. 11. 65. and 28. 02. 66. are represented in the Fig. 6. Mean position angle of vibration plane of EQ Peg at the left top of the figure, during the flare, is actually the same as out of flare, but degree of polarization is reduced by about 0, 7%. The r. m. s. error of degree of polarization for measurements out of flare is $\pm 0,2$ the radius of upper semicircle around point O).





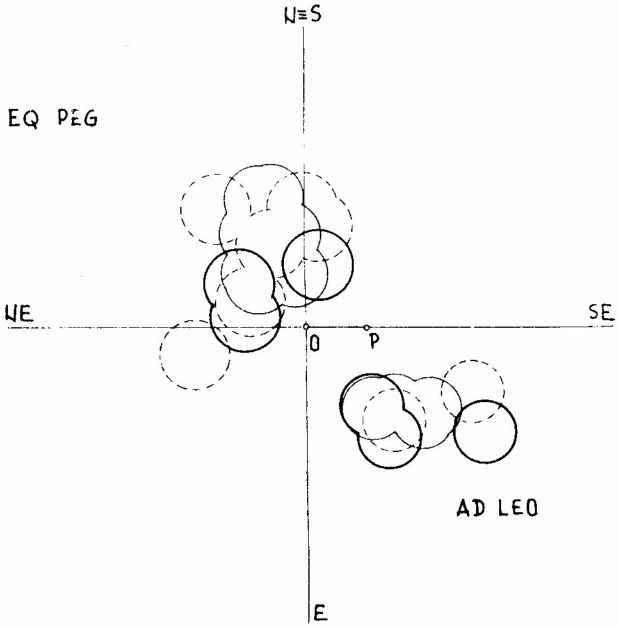
The same small change is seen in the case of flare AD Leo, Fig. 6, down right. There, the change caused by flare results 1, 0% in direction of $2\theta = 105^{o}$, while the r. m. s. error of the group of measurements out of flare is $\pm$ 0, 22% (the radius of lower semicircle around point O).



It seams that the use of an average of each two single successive measurements results out an acceptable compromise between a good time resolution and a high weight mean value. The measurements of 24. 10. 65. elaborated in this way were indicated in Fig, 7 - before flare, 8 - during flare and 9 - after flare. Here is also, applied a polar coordinate system with arguments P and 2θ, and the line OP also amounts to 1%. For a clearer look of the picture, the vectors of polarization are not drawn in full. Their ends are represented with dots, and each phase of observation is marked with mumbers, chronologically. System of dots in each figure is surrounded with an envelope which has been constructed drawing a circle with radius around each dot. The mean values have been obtained so that every measured data took part in formation of mean values twice in combination with the former and the next measurement.

The change of polarization brought in by the flare is seen in deviation of point 1, the first averaged point within the flare, Fig. 8, from the group of points before flare, Fig. 7,. This increase of polarization is shown in Fig. 7, by a vector between points 11 and F, of which is the latter identical with point 1 in Fig. 8. The intensity of vector is 3, 6% and the direction $2\theta = 355^{o}$. The time interval between instants to which we can attribute points 11 and F is 40^{s}, so that point 11 results out of the last two twentysecond measurements, before flare, and point F from the first two measurements after the beginning of the star brightening. Carrying out a mean of the last measurement before flare and the first measurement during flare, between groups of points before and during flare, (between 11 and F), migh be drawn an intermediate point M in Fig 7 and 8. Then, the mentioned increase would be shown by two vectors : from the point 11 to M and from the point M to F, in Fig. 7. However, this method would not change the amplitude of polarization excess brought in by the flare. Beside this abrupt increase of polarization apparently is seen that the group of points before the flare is more compact and the dispersion of points is smaller than during the flare and after the flare.

In the other two cases the mean values of each two successive single measurements do not show a big jump of polarization parameter at the moment of flare. In Fig. 10, they are shown only by the envelopes of groups of points as follows: the thin line shows the points before flare, the thick line shows the points during the flare, and the interrupted lines show the points after the flare.



Conclusions

1. In the biggest one of the three polarimetrically observed flare, a change of degree of polarization and of the plane of vibration of the stellar radiation have been perceived with a considerable probability. The change was most striking in the first minute of the increased brightness, and in the given conditions of observation, it was most recongnisable at the time resolution of about 40^s.

2. In the two smaller and shorter of the three analysed flares, at a time resolution of about 20^s (single measurements) it has been noticed that the first or the first two measurements inside the flare deviate from the group of measurements before the flare, but actually these changes cannot be distinguished from the phenomenon under point 3.

3. The variation of polarization parameters has in all three cases (at the first one more apparently than at the other two later flares) been bigger during and after the flare than immediately before it.

4. In the most thoroughly analysed case (EQ Peg, 24. 10. 65) the mean values which resulted out of 10 and 12 single measurements, indicated the possibility that the changed state in polarization of radiation lasted longer than the optical flare, Therefore, measurements of polarization of UV Ceti stars would be interesting also if they would be done by a slower polarimeter, but with smaller absolute errors.

* * *

The authors are grateful to Dr. Vasilije Oskanjan for his constructive participation in the preliminary discussions of this observational material.

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AN ATTEMPT TO ANALYSE THE FLARE POLARIZATION OF SOME UV CETI STARS

Summary

With a good time resolution the flare polarization of EQ Peg and AD Leo has been 3 times observed during flares, and the results have been phenomenologically analysed. With the time resolution of about 40^{s} (each two successive measurements gave a mean) in one case (EQ Peg, 24. 10.65,) an abrupt change of polarization of about 3% at the beginning of the flare, has been apparently noticed. Single measurements in the other two cases indicated some uncertain variations. There are signs that the change of polarization, which appeared during the flares, has in itself also a component whose duration lasted longer than the optical flares.

POLARIMETRIC OBSERVATION OF RR LYR

J. Arsenijević

Summary

The measured values of polarization are expressed by p and θ for photometric regions B and V, table 1. The mean values of these quantities are determined and found that for the region V $p = 0^{m}.0055 \pm 0^{m}.0015$, $\theta = 81^{o} \pm 7^{o}$ (9 measurements) and for the region B $p = 0^{m}.0051 \pm 0^{o}.0007$, $\theta = 59^{o} \pm 15$ (7 measurements).

Introduction

Some characteristic changes of brightness of short-period cefeids and flare stars of UV Ceti type as well as Balasch - Detre's opinion (1960), led Oskanjan (1964) to express his own assumption on the eruptive character in change of brightness of short-period cefeids. One observation of increased polarization of radiation during the eruptive increase of brightness, observed by Oskanjan (1964a) at Biurakan observatory, and three changes of polarization of some UV Ceti stars, observed at the Belgrade observatory, gave incentive that the assumption on likeness of mechanism which bring about the brightness change of these two type of variables should be substantiated by eventual change of polarisation of RR Lyr radiation. So, to Oskanjan's suggestion, the polarimetric observation of RR Lyr was undertaken.

Observation and analysis

A Schmidt telescope (1900/1800/13500 mm) from the observatory of Torun University and a differencial polarimeter from Astronomical Institute of Polish academy of science was given at our disposal for the polarimetric measurements of RR Lyr in the period of time from 6th to 30th June 1966. Themeasurements were done in Cassegren focus of the telescope in the region B and V of photometric system UBV. For the region B - combination of filters Schott BG12 of 1 mm and 2 mm Schott GG13 was used, and for the region V 2 mm Schott GG14.

Each of Stokes parameters p_x and p_y was determined on the basis of measurements in two position angles. One measurement of degree of polarization and one measurement of position angle of the plane of Vibration of the electric vector in equatorial coordinate system, lasted about 35 minutes. Measurement in a number of position angles would increase precision of measurement, but, simultanously, it would prolong the time of observation to more than 0. 1 period. It wold be very inconvenient as it was desired to establish eventual existence of polarization change with change of brightness. The corrections of the measured values to the standard system, suggested by Serkowski (1960), were done according to the data received from the collaborator at the Institute of Astronomy Rucinsky S. (1966). The instants of maxima were determined according to Cessewitsch's (1966) ephemeris. The mean errors of degree of polarisation $\mathcal{E}_p$ and the mean errors of position angle $\mathcal{E}_\theta$ for single measurements were determined according to Hall and Serkowski (1963).

In the Table 1 we have the obtained values of degree of polarization p in stellar magnitudes, position angle θ in equatorial coordinate system, corresponding mean error $\mathcal{E}_p$ and $\mathcal{E}_\theta$, phases corresponding to the middle of the interval of observation, corresponding instants of universal time UT and the dates. The Table is arranged according to the increasing phases.

T A B L E 1.

Date	UT	Phase	P	ε_p	θ	ε_θ
	Photometric region V					
1966. VI. 16.	22^h58^m	0.02	0^m0036	0^m0010	90^o	8^o
11	21 46	0.10	0. 0075	0. 0003	84	1
15	21 25	0.12	0. 0103	0. 0015	84	4
23	22 10	0.31	0. 0048	0. 0025	58	15
14	21 44	0.40	0. 0078	0. 0027	78	10
18	21 49	0.45	0. 0079	0. 0034	90	12
23	24 08	0.45	0. 0080	0. 0015	30	5
13	23 23	0.75	0. 0011	0. 0022	69	57
12	22 00	0.84	0. 0056	0. 0023	81	12
	Photometric region B					
16	23 38	0.06	0. 0057	0. 0020	54	10
15	22 09	0.18	0. 0038	0. 0011	97	8
23	23 18	0.39	0. 0020	0. 0019	44	27
18	24 40	0.51	0. 0067	0. 0003	60	1
22	22 20	0.55	0. 0064	0. 0035	66	16
22	23 16	0.61	0. 0051	0. 0011	44	6
12	22 52	0.91	0. 0046	0. 0020	57	12

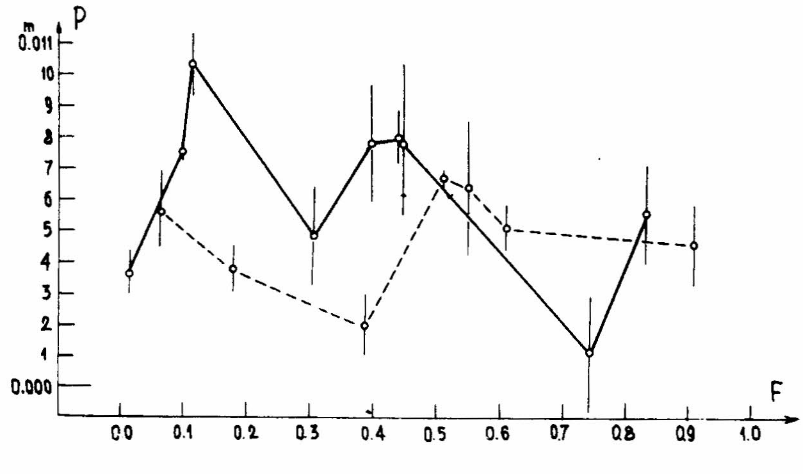

Fig. 1 The degree of polarization of radiation of RR Lyr depending on the phase of brightness change. The ordinate indicates the measured degree of polarization in stellar magnitudes and the abscissa indicates the phases of brightness change. The full curve shows polarization in photometric region V, and the iterrupted curve shows polarization in the region B. Each dot represents one measurement with corresponding mean errors ε_p.

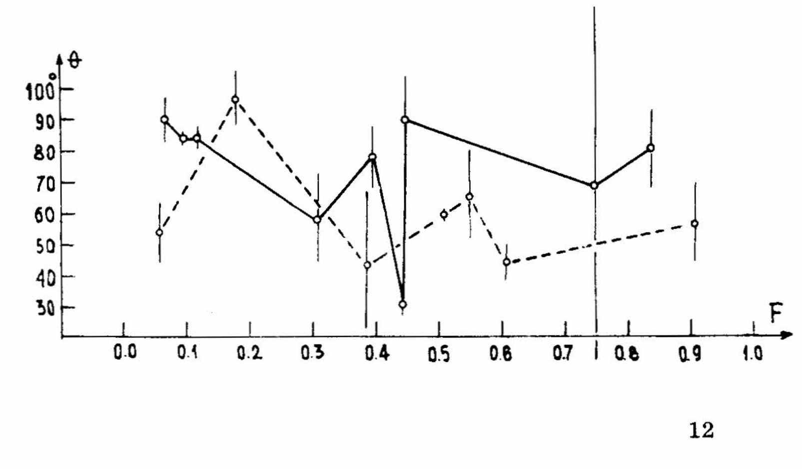

Fig. 2 Position angles of polarization in equatorial coordinate system depending on the phase of brightness change. The Full curve shows position angles in the photometric region V and the interrupted curve the same in the region B. Each dot in the graph represents one measurement with the corresponding mean error ε_θ.

The curves in Fig. 1 represent the obtained values of polarization P for the two measured photometric regions depending on the phases of brightness changes F. Doubled values of mean errors $\mathcal{E}_p$ are indicated by the lines through the corresponding points. In the same way are chown the measured values of position angles θ depending on the phase F in Fig. 2.

The curve in Fig. 1 does not indicate that the degree of polarization depends on the change of brightness i.e. on the phase. At the first sight it seams, that the highest measured value of polarization is in the vicinity of the maximum brightness, while the lowest measured value is in the vicinity of the minimum brightness, but that concerns only the photometric region V. For the region B, the highest measured value corresponds to the phase 0.5.

On account of the small amplitude of polarization with respect to the errors of measurements, we may say that the systematic changes in this group of measured data are not established.

Mean values of the measured polarisation

With view to the small number of measurements and obtained values of polarization P and θ with their errors unable to prove the original assumption, it would be most logically to suppose, in this case, that the differences of measured values are due to accidental errors in measurements, as well as to determine mean values of measured quantities for each of the two photometric regions separately.

The mean value of degree of polarization has been determined according to the formula $\bar{P} = \sqrt{\bar{P}_x^2 + \bar{P}_y^2}$. Values $\bar{P}_x$ and $\bar{P}_y$ are weighted mean values out of 9 measurements for region V and 7 measurements for region B. The weight resulted from the mean errors of Stokes parameter $\mathcal{E}_x$ and $\mathcal{E}_y$ of single measurements. The mean values of position angle have been determined according to the formula $tg2\theta = \frac{\bar{P}_y}{\bar{P}_x}$. R. m. s. error of weighted mean of degree of polarization has been determined according to the formula $\sigma_{\bar{P}} = \sqrt{\frac{\sigma_{\bar{P}_x}^2 + \sigma_{\bar{P}_y}^2}{2}}$. The weighted mean values of degree of polarization P and position angle Θ as well as the corresponding R. m. s. errors obtained in this way are:

V region	B region
$P = 0^m.0055 \pm 0^m0015$	$P = 0^m.0051 \pm 0^m.0007$
$\theta = 81^o \pm 7^o$	$\theta = 59^o \pm 15^o$.

Up to now polarimetric measurements of RR Lyr carried out by other authors, according to the available data are indicated in the Table 2.

T A B L E 2.

Period of observation	Authors	P	θ	Errors in P
1956 - 57	T. Schmidt (1958)	$0^m.0073$	53^o	$0^o.0015$ mean
1956 - 58	A. Behr (1959)	0. 0068	41	0. 0011 "
1961	N. M. Šahowskoy (1963)	0. 0035	87. 8	0. 0020 sq. mean.

Our measurements in the region V agree, within the limits of errors, with the measurements carried out by Šahowskoy (1963) and Behr (1959), while Behr's observations, also within the limits of errors, agree with Schmidt's observations (1958). Concerning the differences of measured values of polarization carried out by various authors for much brighter stars used as standards for polarimetric measurements (Serkowski 1960), the agreement among values given in the Table 2 together with our values, may be estimated as quite good. The differences in position angles are also understandable having in mind small values of degree of polarization. Values measured by Šahowskoy are systematically somewhat lower to those given by Schmidt. All together, these data indicate the fact that the differences of measured values of polarization can be attributed only to the inaccurate measurements but not to the changes of polarizations of the star itself.

Quite another question arises, whether the measured polarization comes from the star itself, or, from the interstellar matter. For the interstellar polarization goes the sign of the difference of degree of polarization between the two measured polarimetric regions, being the same as at the interstellar polarization, resulting out of the measurements carried out by Coyn and Gehrels (1960). On the quantitative agreement between the measured degrees of polarization and the interstellar polarization, much cannot be said, because the field of measured interstellar polarization in the vicinity of RR Lyr happens to be extremely unhomogeneous.

Conclusion

The change of polarization of the RR Lyr star has not been established. Still, the existance of small changes of polarization, which are below the possibilities of our method of measurement, cannot be excluded. By the momentary conclusion that there are no changes of polarization, the anly a possibility for identification of the origin of measured polarization is eliminated. It might not be quite justified to attribute the measured polarization to the interstellar medium, especially when we consider that it concerns a variable star whose mechanisam of changes of the total radiation from the point of polarization is not sufficiently known.

Finally, I am glad to express with utmost pleasure my thanks to Prof. Piotrowsky of Institute of Astronomy in Warsaw; to Prof. Ivanowsky, director of Torun University Observatory, as well as to the collaborators who were so kind as to enable these observations.

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ANALYSE DE L'INFLUENCE DE VARIATION D'INCLINAISON DES AXES DU TUBE ZENITHAL (A BELGRADE) SUR LA VALEUR DE LA LATITUDE

Par M. Djokić

On a commencé à ramasser le matériel d'observation se rapportant aux variations saisonnières d'inclinaison d'alidade et d'axe de rotation du tube zénithal en avril 1959., d'après la méthode utilisé à Mizusawa et décrite aux articles [1] et [2], et terminé en mai 1965. En effet, l'exploration du niveau d'axe de rotation du tube zénithal en mars 1965. a montré les possibilités d'utilisation de ce niveau devenues limitées (ce qu'on n'avait pas trouvé dans des explorations précédentes). A la fin de 1965. et au début de 1966. on a travaillé sur l'emplacement de l'ampoule de ce niveau par un niveau nouveau et on peut dire qu'après avoir fait cet emplacement, on a continué l'observation de nouveau et c'est cet emplacement qui a causé la duration assez longue.

L'analyse du matériel d'observation ramassé dès le mois d'avril de 1959. jusqu'au avril de 1962. montrée au [1] se rapporte aux variations saisonnières et journales des deux axes d'instrument sur le plan de la première verticale. A cet occasion-là, on a déduit les variations saisonnières d'inclinaison des mesures de soir. Mais, les mesures de soir, on les a faits même sur le plan méridional dès le mois de mai 1961 jusqu'à la fin d'avril 1962 et dès le mois d'avril 1963 jusqu'à la fin du janvier. On a fait des mesures de ce genre même dès le mois d'avril 1961 jusqu'au avril 1962, à l'exeption des mesures de jour (tous les jour à 10 h) qu'on faisait au pavillon fermé, c'est-a-dire dans des conditions inchangées. On a fait des mesures de soir a l'occasion des observations de latitude.

Dès le 5. jusqù'au 6 de mai 1963., on a fait les mesures chaque heures sur 24 heures, en vue de obtenir les variations de jour d'inclinaison des deux axes. C'est a l'occasion de cet expériment qu'on a même lis les niveaux de Talcott à toutes les quatres positions d'instrument (KE, KW, KS, KN) en voulant comparer l'inclinaison dédouite du niveau de Talcott (β) avec l'inclinaison d'axe d'alidade (θ) sur les deux plans. Cette comparaison nous a indiqué qu'il est nécessaire de suivre les variations d'inclinaison des axes d'instrument sur les deux plans (plan de méridien et sur le plan de la première verticale) car il y a une différence systèmatique entre $\frac{\beta}{z}$ et θ pour les deux plans, ce qu'on peut voir au tableau 1. Depuis 1967. on ramasse régulièrement les données sur cette différence systematique d'inclinaison, cela veut dire qu'on fait la lecture du niveau de Talcott chaque fois qu'on fait les mesures d'inclinaison des axes d'instrument.

TABLEAU 1

$$\Delta'' = \frac{\beta''}{2} - \theta''_{z}$$

	0^h	2^h	4^h	6^h	8^h	10^h	12^h	14^h	16^h	18^h	$2o^h$	22^h	May
Δ''EW	+ 2!'49	+ 2!'85	+ 2!'84	+ 2!'36	+ 2!'60	+ 3!'04	+ 3!'12	+ 3!'93	+ 3!'98	+ 3!'63	+ 3!'04	+ 2!'47	+ 3!'03
Δ''SN	+ 1. 03	+ 1. 04	+ 1. 03	+ 1. 00	+ 0. 93	+ 0. 60	+ 0. 54	+ 0. 87	+ 1. 11	+ 1. 38	+ 0. 91	+ 0. 61	+ 0. 92

2. Les données d'observation sur les variations saisonnières d'inclinaison des deux axes d'instrument obtenues par les mesures de matin et de soir sur les deux spheres de 1959 à 1965, c'est-à-dire de 1961 à 1962 sont réduites aux systemès des coordonnées dont l'origine des coordonnées coincide aves l'origine de toutes les periodes observées. Le nivellement d'instrument qui est de temps en temps indispensable, exige les rédactions de ce gen.·e. Au tableau 2 il y a le numéro des nivellements de tube zénithal donné pour tous les années pendant toute une période d'observation. La valeur moyenne du numéro de nivellement est déduite des années complètes d'observation.

TABLEAU 2

Anné	1959	1960	1961	1962	1963	1964	1965	Moy
Num. de nivell.	(4)	3	5	7	5	2	(1)	4.5

D'après les donnés du [1] le numéro de nivellement moyen par an du tube zenithal à Mizusawa est deux fois plus petit [2.1] pour la période de 1933 à 1949.

Il est déjà souligné à l'article [3] que le numero de nivellement de l'instrument montre sa stabilité qui est notable à Mizusawa. Puisque les formules de la réduction d'inclinaison sont:

$$\theta = \frac{1}{2}(d_e + d_w) \quad \text{et} \quad \Psi = \frac{1}{2}(d_e - d_w)$$

Pour la premiere verticale et

$$\bar{\theta} = \frac{1}{2}(d_s \quad d_n) \quad \text{et} \quad \bar{\Psi} = \frac{1}{2}(d_s - d_n)$$

Pour le plan de méridien, où d_e, d_w, d_s, d_n représentent les inclina isons d'axe de rotation par rapport au plan horizontal dans les quatres positions d'instrument: KE, KW, KS, KN; toutes les données de d avec des index correspondants sont réduits aux systèmes des coordonnées, on a calculé ses valeurs mensuelles moyennes desquelles on a déterminé les valeurs pour θ et ψ dans les deux plans.

C'est de cette manière que les valeurs mensuelles pour θ et ψ sont déduites et après les nivelées par la méthode des centres des triangles pondérés on a appliqué l'analyse harmonique.

A l'occasion de mesure de nuit et de mationn on a lis la temperature de l'istrument(T_i) et puis, de là, on a formé les valeurs mensuelles moyennes nivelées par la méthode des triangles pondérés et puis on a appliqué l'analyse harmonique en vue de souligner ce rapport déjà connu entre l'axe et la temperature de l'instrument.

Au tableau 3 on a donné les valeurs moyennes mensuelles nivelées pour θ et ψ déduites pour le plan de la première verticale des mesures de soir pendant la période de 1959 a 1965.

TABLEAU 3

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
θ	-16."86	-17."96	-19."33	-20."77	-21."42	-21."91	-21."48	-20."98	-20."01	-19."01	-17."75	-16."87
ψ	- 0.96	- 0.51	- 0.51	- 0.70	- 1.55	- 2.23	- 2.81	- 2.93	- 2.74	- 2.43	- 1.93	- 1.44

D'après les données du tableau 3, on a déduit les formules harminiques suivantes (t est donné en mois).

$$\theta = -19.''53 + 2.''47 \sin(t + 111^{\circ}) + 0.''30 \sin(2t + 99^{\circ}) + 0.''06 \sin(3t + 13\circ),$$

$$\psi = -1.''73 + 1.''23 \sin(t + 49^{\circ}) + 0.''16 \sin(2t + 297^{\circ}) + 0.''02 \sin 3t.$$

La figure 1 contient l'interprétation graphique des données du tableau 3 et aussi l'interprétation de ces formules harmoniques.

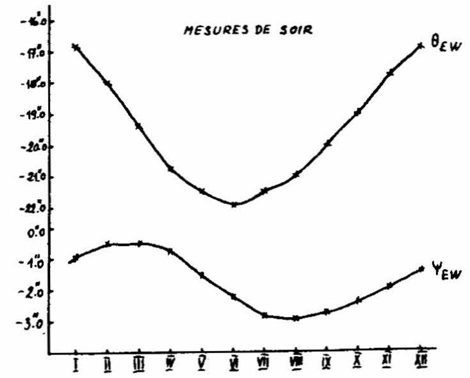

Fig. 1

Au tableau 4 on a donné les valeurs moyennes mensuelles nivelées pour θ et ψ déduites pour le plan de méridien des mesures de nuit pour les périodes de 1961 à 1962 et de 1963 à 1965.

TABLEAU 4

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
θ	+9.″08	+7.″39	+4.″77	+4.″08	+3.″08	+2.″66	+2.″95	+4.″07	+6.″06	+8.″06	+9.″63	+10.″68
ψ	+1.66	+2.14	+2.76	+2.29	+1.35	+0.25	-0.04	-0.13	-0.05	+0.18	+0.72	+1.12

D'après les données du tableau 4 on a déduit les formules harmoniques suivantes:

$$\theta = +6.''04+3.''80 \sin (t+125^{\circ}) + 0.''55 \sin (2t + 171^{\circ}) + 0.''18 \sin(3t + 131^{\circ})$$

$$\psi = +1.''02+1.''33 \sin (t+44^{\circ}) + 0.''32 \sin (2t + 305^{\circ}) + 0.''14 \sin(3t + 214^{\circ}).$$

Et la figure 2 contient l'interprétation graphique des donnees du tableau 4 et aussi l'interprétation de ces formules harmoniques.

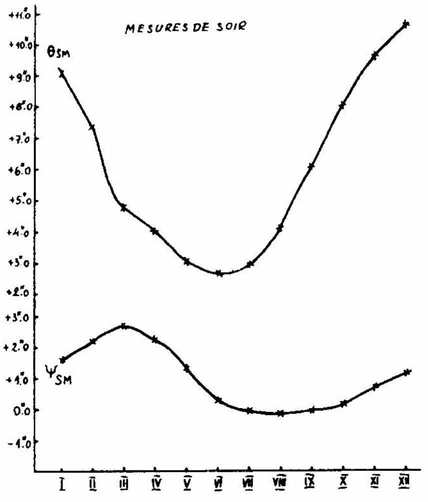

Fig. 2

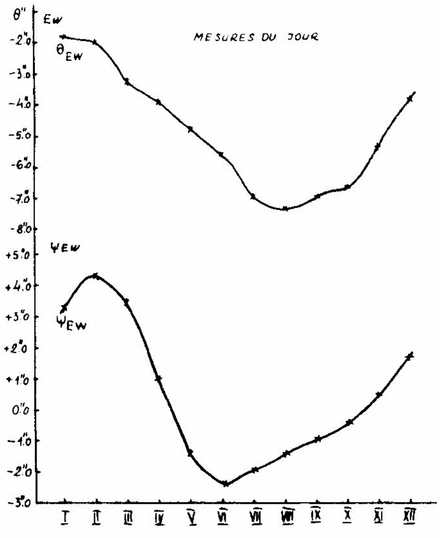

Fig. 3

Le tableau 5 contient les valeurs moyennes mensuelles nivelèes pour θ et ψ déduites pour le plan de la première verticale des mesures du jour pour la période de 1961 à 1962.

TABLEAU 5

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
θ :	-1.″84	-1.″96	-3.″21	-3.″90	-4.″72	-5.″52	-6.″93	-7.″38	-6.″95	-6.″73	-5.″34	-3.″73
ψ :	+3.26	+4.31	+3.55	+1.05	-1.39	-2.42	-1.96	-1.45	-0.97	-0.42	+0.47	+1.78

Des données du tableau 5 on a déduit les formules harmoniques

$$\theta = -4.''85+2.''57 \sin (t+57^{\circ}) + 0.''45 \sin (2t + 94^{\circ}) + 0.''35 \sin (3t + 68^{\circ})$$

$$\psi = +0.''48+2.''95 \sin (t+75^{\circ}) + 1.''02 \sin (2t + 9^{\circ}) + 0.''19 \sin (3t + 276^{\circ}).$$

qu'on peut trouver sur la figure 3.

La tableau 6 contient les valeurs moyennes mensuelles nivelées pour θ et ψ déduites pour le plan méridional des mesures de jour pour la période de 1961 à 1962.

TABLEAU 6

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
θ :	+0″34	-0″23	-0″40	-1″70	-2″53	-3″89	-3″97	-3″69	-2″67	-1″59	-0″46	+0″04
ψ :	+1.08	+1.54	+1.49	+0.62	-0.85	-2.26	-2.08	-1.74	-1.47	-1.20	-0.54	+0.20

Des données du tableau 6 on a déduits des formules harmoniques qu'on peut trouver, ainsi que les données de ce tableau, dans la figure 4

$$\theta = -1''73 + 2''15 \sin(t + 91^{\circ}) + 0''20 \sin(2t + 264^{\circ}) + 0''06 \sin 3t$$

$$\psi = -0.40 + 1.85 \sin(t + 64^{\circ}) + 0.57 \sin(2t + 342^{\circ}) + 0''19 \sin(3t + 208^{\circ})$$

Le tableau 7 contient les valeurs moyennes mensuelles nivelees de température de l'instrument (Tis)-des mesures de soir, pour la période de 1959 à 1965.

TABLEAU 7

T_{is} :	-1°1	-0°1	+4°7	+10°0	+15°4	+18°4	+20°3	+19°1	+15°9	+11°0	+5°8	+1°1

La formule harmonique correspond aux données du tableau 7

$$T_{is} : +10^{\circ} + 10^{\circ}6 \sin(t + 267^{\circ}) + 0^{\circ}6 \sin(2t + 255^{\circ}) + 0^{\circ}2 \sin(3t + 214^{\circ})$$

Le tableau 8 contient les valeurs moyennes mensuelles nivelées de température de l'instrument (T_{im}) des mesures de jour pour la période de 1961 à 1962.

TABLEAU 8

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
T_{im} :	+1″9	+2°0	+5°9	+10°9	+17°5	+20°5	+22°5	+21°6	+18°9	+14°5	+8°7	+4°5

La formule harmonique correspond aux données du tableau 8

$$T_{im} : +12^{\circ}4 + 10^{\circ}5 \sin(t + 262^{\circ}) + 0^{\circ}5 \sin(2t + 223^{\circ}) + 0^{\circ}2 \sin(3t + 90^{\circ}).$$

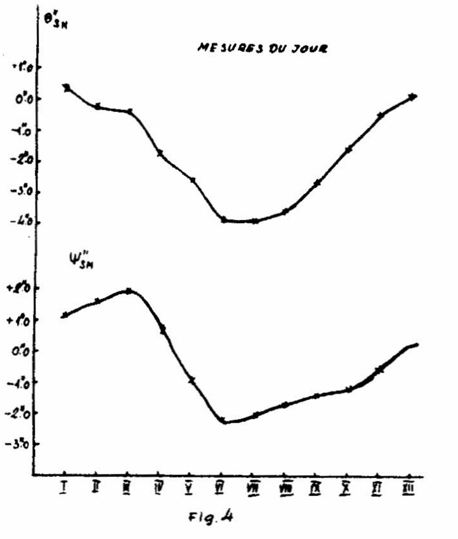

Fig. 4

3. Ce qui est évident dans toutes les formules harmoniques pour θ c'est que le terme annuel est fort plus grand que les autres termes de ces formules et que les angles de phase des termes annuels coïncident, spécialement pour les deux plans où on a effectué les mesures de soir ainsi que celles de jour.

Si on compare d'apres [4] , puisque le tube zenithal et l'instrument de passage se trouvent tous les deux à l'aile de l'est du pavillon astrogéodésique de L'Observatoire astronomique à Belgrade sur les pilliers non-mis en contact, les données sur θ aux tableau 3 et 4 avec les données sur T_{is} du tableau 7, on peut voir qu'il n'y a pas de retard d'extremum de la température de l'instrument, ce qu'on a déjà constaté au [4] .

Ce fait est probablement la conséquence des conditions différentes sous lesquelles an a effectué les mesures de nuit (les temps de mesure n'étaient pas les mêmes a l'oceasion de l'observation de latitude, puis on a effectué les mesures même au pavillon fermé, spécialement en hiver quand il n'y avait pas d'observation de latitude).

Au [1] les variations saisonnières de θ ne sont pas comparées avec les variations saisonnierès de temperature du pavillon ou de l'instrument même (T_i). Si on fait cette comparaison d'après ces données on ne trouvera non plus le retard souligné à [4] . Les causes sont à peu près cemblables aux causes déjà citées, car même à Mizusawa, les données sur les variations saisonnières d'inclinaison sont ramassées a l'occasion de l'observation de latitude.

Mais, en comparant les données sur θ tableaux 5 et 6 avec les données sur T_{im} du tableau 8, on voit le retard dont on a déjà parlé, et par conséquent, on a trouvé le retard pour le plan de la première verticale du même ordre de grendeur qu'au [4] . Pour le plan de méridien, cependent, les extremums d'inclinaison θ et de température (T_{im}) coïncident en temps, ce qui est probablement en relation avec l'époque du jour où la mesure est faite. La constante des conditions de mesure dont on a parlé au début de l'article, il semble qu'est devenue évidente. Pour accentuer les rapports entre l'inclinaison dans les deux plans et la température T_{im} (ce qu'on a fait au [4]) on a retenu seulement les termes libres et les termes annuels des formules harmoniques.

La figure 5 représente l'interprétation graphique de ces formules harmoniques réduites.

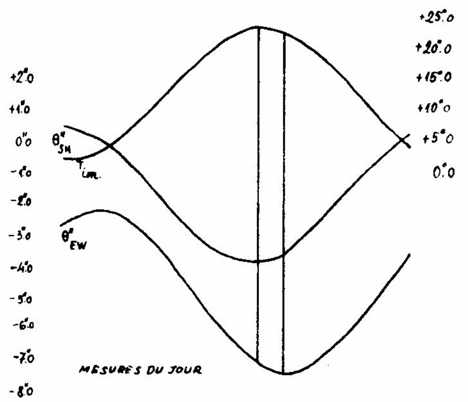

Fig. 5

Au [1] les variations saisonnières d'inclinaison s'attribuent à la variation inégale du pillier ou l'instrument se trouve, et dont la cause est la variation saisonniere de l'humidité.

Au [2] on a comparé les variations saisonnieres d'inclinaison avec le cours saisonnier des précipités en utilisant les données de l'Observatoire météorologique à Belgrade. Puisqu'il faut ramasser les données sur les précipités a la proximité du pavillon où on fait l'observation de la variation d'inclinaison, on ne peut pas complètement croire en valeur des résultats ainsi obtenus, bien qu'ils prouvent qu'il y ait une relation entre la variation saisonnière d'inclinaison θ et le cours saisonnier des précipités.

Les données sur la variation d'inclinaison θ dans le plan de la première verticale au cours de toute la période de l'observation mises en graphique (figure 6) indique le fait qu'il y a une variation séculière de ce terme du même type qu'on a déjà effectué au [4] pour l'instrument de passage et son pillier. Cette variation séculière d'inclinaison est donnée pour la période d'observation de 1959 a 1965. par la formule

$$\theta = -0''.46\ t - 2''.27$$

(t est donné en mois : des le mois d'avril 1959.)

Le coéfficient de direction est un peu plus petit en valeur absolue que les coéfficients de direction des formules semblables données au [4] A l'occasion d'appréciation de ce fait, il faut tenir compte de ce que les données sur la variations d'inclinaison sont obtenues en utilisant deux instruments différents. Puis, les données se rapportent aux deux pilliers qui se trouvent l'un près de l'autre. Ce qui est peut-être d'une importance très grande, c'est qu'il y a une intervalle de quelques années entre deux périodes de ramassage des données pour ces deux instruments.

En comparant les valeurs de θ des tableaux 3 et 4 ainsi que les valeurs de θ des tableaux 5 et 6, on obtient les graphiques se trouvant aux figures 7 et 8 respectivement.

Ces graphiques complètent l'image de mouvement du pillier d'instrument. Les points qui correspondent aux positions moyennes mensuelles du pillier, s'arrangent en sens direct aux mesures de soir ainsi qu'aux mesures de jour.

4. Dans des formules de ψ le terme annuel, aussi, est beaucoup plus grand que les autres termes de ces formules, tandis que les amplitudes et les angles de phase des termes correspondants coincident en mesures de soir ainsi qu'en mesures de jour.

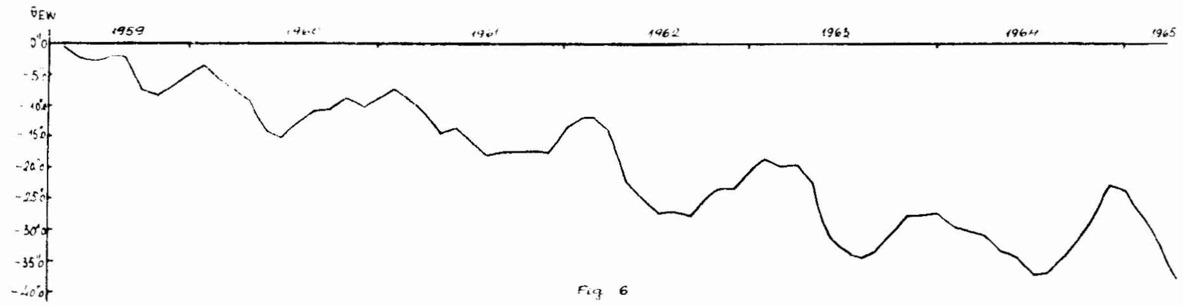

Fig 6

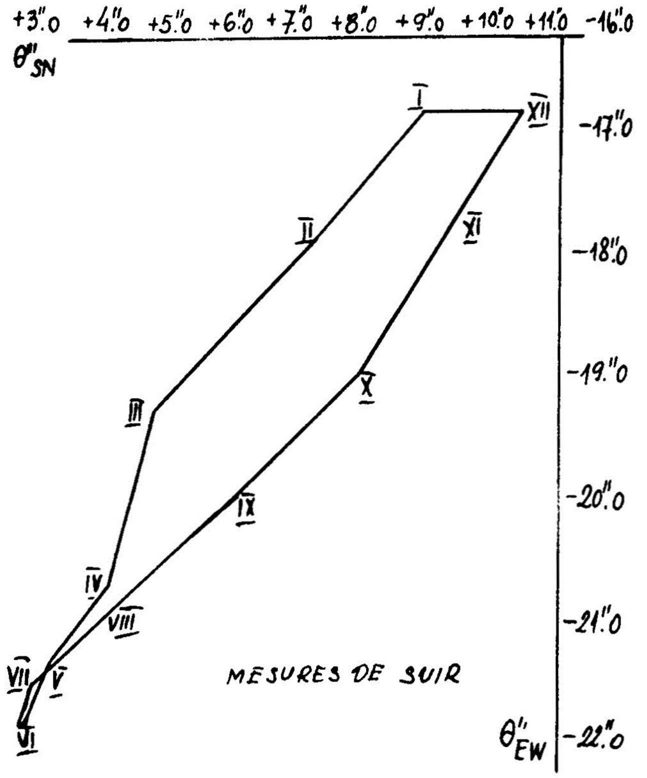

Fig. 7

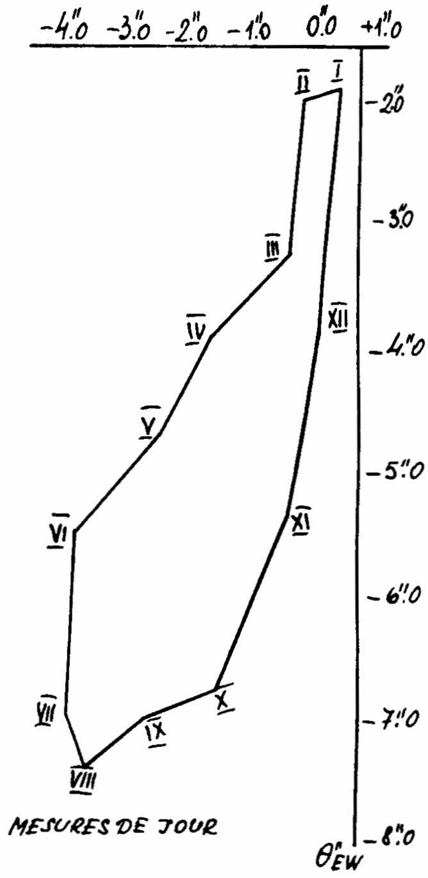

Fig. 8

Les variations de tous les inclinaisons ψ tendent vers les valeurs positives en mois d'hiver, et en mois, d'été vers les valeurs néga - tives-ce qu'on a constaté au [1] .

Les figures 9 et 10 montrent la comparaison graphique des valeurs de ψ des tableaux 3 et 4 avec les valeurs de T_{is} du tableau 7, et les figures 11 et 12 montrent la comparaison graphique des valeurs de ψ des tableaux 5 et 6 avec les valeurs de T_{im} du tableau 8.

Au [1] on observe les variations de ψ en dependant de variation de température de l'instrument du pavillon, c'est-à-dire l'élargissement inégal des tourillons d'axe de rotation pendant lequel on constate que cette côté de l'instrument où est l'objectif, est plus sensible à l'influence de température que la côté avec le poids d'équilibration. Enfin, on mentionne que la chaleur de l'ampoule éléctrique, se trouvant dans le poids d'équilibration, qu'éclaire le champs visuel, peut pro - voquer certaines variations au cours des observations de latitude.

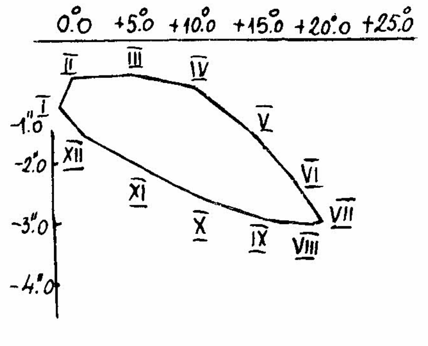

Fig. 9

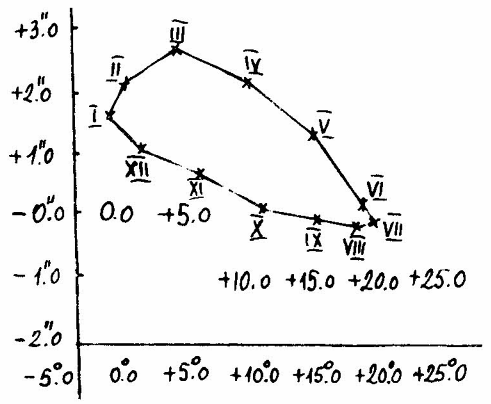

Fig. 10

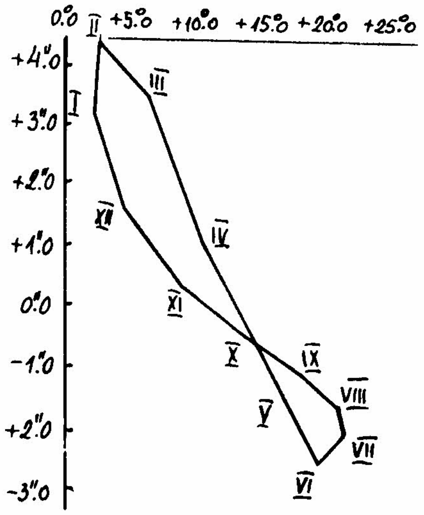

Fig. 11

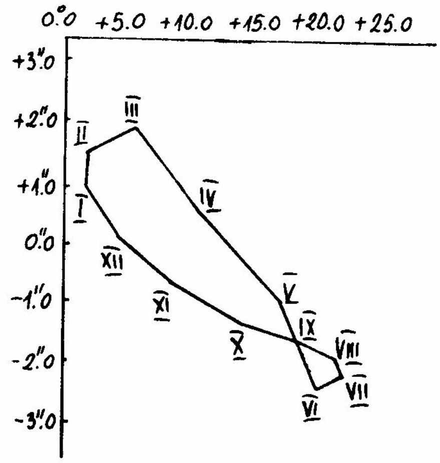

Fig. 12

La figure 13 représente la variation d'inclinaison ψ des mesures de soir dans le plan de la premiere verticale pour toute la période d'observation. On peut voir que ψ dans la première partie de la période varie un peu, tandis qu'à la deuxième partie tend vers les valeurs positives.

Le passage des valeurs négatives aux valeurs positives est fait à la fin de 1961. et au début de 1962.

Si on compare la figure 13 avec celle-là 6, on peut voir la tendance de ψ vers l'augmentation séculière.

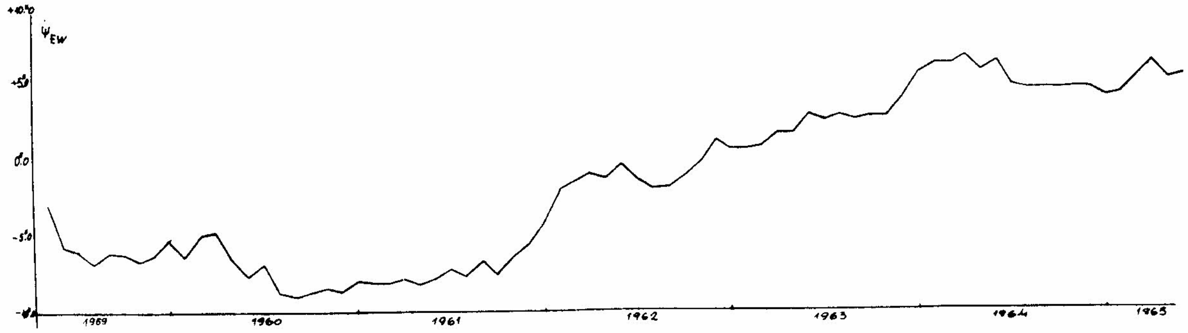

Fig 13

5. La publication [1] donne le ciriterium des limites de la distance zénithale des couples de Talcott et les costantes d'instrument:d'azimut (a) d'inclinaison d'axe de rotation (b) et de collimation (c) entre lesquelles l'erreur de la latitude momentanée $\delta\varphi$ d'un couple de Talcott soit plus petite que 0."005, c'est-à-dire 0."0005.

Le nouveau programme d'observation de latitude d'après lequel on fait des observations à L'Observatoire astronomique de Belgrade, à partir de 1. du janvier 1960, donne les distances moyennes zénithales des groupes particuliers des couples de Talcott entre 4^{o} et 11^{o}. D'après ce criterium cité à [1] en cas des distances zénithales de ce genre, toutes les trois constantes d'instrument peuvent être entre ± 25" et ± 22" pour pouvoir obtenier $\delta\varphi <$ 0".005 Pour pouvoir obtenir $\delta\varphi <$ o."0005 les limites sont ± 7."4. c'est-à-dire ± 7."0.

Au cours de toute la période d'observation traitée dans cet article, les valeurs d'inclinaison d'axe de rotation de l'instrument vers le plan horizontal dans le plan de la première verticale (d_e et d_w) (qui ne sont par corrigées à couse de rectification) se trouvaient entre les limites de ± 12."C'était à l'occasion des mesures de soir, tandis qu'au cours des mesures de jour cette inclinaison était ± 7."0, dans le meme plan.

S'il s'agit de collimation-elle se trouvait dans les limites tres étroites, dès le début de l'observation d'après le nouveau programme de latitude. La distance de ces limites était une dizaine de secondes d'arc.

Cependant, les valeurs d'azimut étaient dans les limites plus larges, en effet, de + 85" a- - 62" pour la pèriode de 1961 à 1965.

La publication [5] attribue ce fait à la nature de l'instrument même et à la méthode d'observation. C'est à l'occasion de l'observation que son tube se tourne autour de l'axe de l'alidade, et par conséquent, ne peut pas être toujour en une même position. On voit que, s'il s'agit de l'inclinaison et de collimation, les conditions posées au [1] sont complètement satisfaisantes. Les limites d'azimut en 1966 et en 1967 étaient aussi satisfaisantes, de + 27" à-11."

* * * *

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L I T T E R A T U R E:

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R É S U M É

On a donné l'analyse du materiel d'observation sur la variation d'inclinaison d'axe d'alidade et d'axe de rotation du tube zénithal à Belgrade, ramassé pendant la période de 1959 à 1965 pour le plan de la première verticale (E-W), et pendant les périodes de 1961 à 1962 et de 1963 à 1965 pour le plan meridional (S-N), à l'occasion de l'observation de latitude. On a donné, aussi l'analyse du matériel d'observation ramassé au cours de période de 1961 à 1962 en faisant les mesures tous les jours à 10h (les mesures de jour) dans les deux plans.

On a souligné les caractéristiques de variation d'inclinaison des deux axes de l'instrument.

On a decouvert la variation séculière de l'inclinaison d'axe d'alidade dans le plan de la première verticale et pour la période de 1959 à 1965, semblable à celle-là de l'instrument de passage de l'Observatoire astronomique de Belgrade se trouvant en un pavillon avec le tube zénithal.

On a effectué que l'inclinaison d'axe de rotation du tube zénithal vers le plan horizontal avait les limites de $\delta\varphi$ permises par le criterium de la publication [1], au cours de toute la période d'observation, de 1959 à 1965.

INVESTIGATION OF THE ADJUSTMENT OF BELGRADE VERTICAL CIRCLE TUBE

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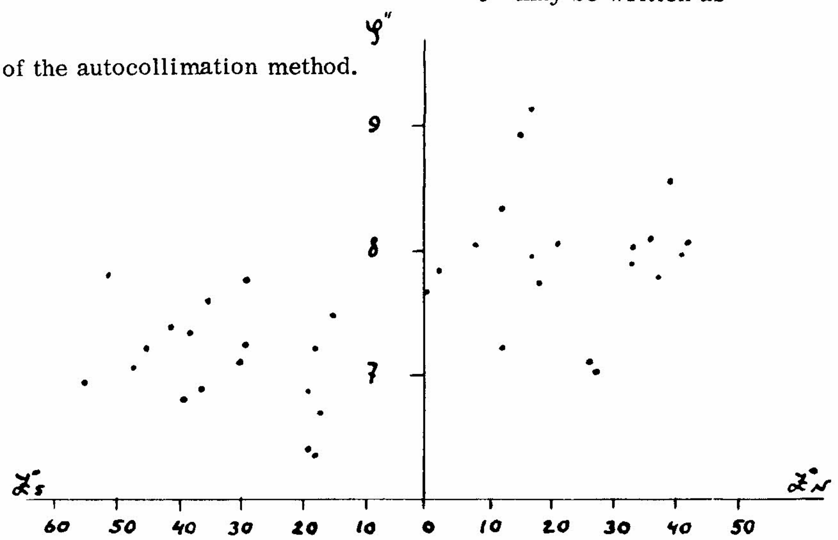
In last years three big classical meridian instruments the meridian, transit and vertical - all 19/258 cm - were mounted and put in operation at the Belgrade Astronomical Observatory. All the instruments were received from the Askania Werke in 1923 [1] . Observations made in 1968 with the large Vertical Circle (BVC) after its mounting in a new building showed that the latitude obtained from the north and south stars had systematic difference [2] . Fig. 1 shows the latitude kindly communicated to the author by Dr. G. Teleki. One can see from this figure that the latitudes derived from observations of the north stars are larger than those derived form observations of south stars. The mean difference determined from 227 observations of 19 north and 18 south stars is 0".78.

In 1969 the author investigated the position of the line of vision of the BVC in dependence of zenith distance. The autocollimation method was applied without additional measurement of deflection of eyepiece end of the tube [3] . For autocollimation measurements we make use of the flat mirror of reasonably high quality (ϕ = 40, d = 7, N = 0, 5) and autocollimation ocular designed by the chief mechanic of the Belgrad Observatory L. Paunović. The stiff attachment of the mirror to the cell before the objective glass was made like at Golosejevo [4] by means of the duraluminium disk with the central hole for mirror and threaded spring ring.

On the Fig. 2 A', A" are the centre of cross-wire and its reflected image accordingly. B' is the rear nodal point of the objective. γ = A' B'A" is autocollimation angle. α, β are angles of flexure of the ocular and objective ends of the tube accordingly. Θ is the angle between the normal N to the mirror and the axis AB of the cube which is at the same time sight-line of the ideal rigid nondeformable tube.

Accordingly to this scheme the angle γ may be written as

Fig. 1 Scheme of the autocollimation method.



$$\gamma = \alpha - \beta + 2\theta \qquad (1)$$

In practice the autocollimation readings A_z are measured instead of the angle γ . To obtain the autocollimation readings A_z one should make coincide of the direct and reflected images for any zenith distance Z.

When investigating the Golosejevo Wanshaff vertical circle it was found [5] that the A_z may be written as (the clamp West)

$$A_z = A_o + \gamma_o \operatorname{Sin} Z \pm \Delta\gamma_o \operatorname{Cos} Z \qquad (2)$$

Where A_o is the zeropoint of the micrometre which may be considered as autocollimation reading for a perfect nondeformable tube. γ_o, $\Delta\gamma_o$ are autocollimation angles in horizontal and vertical positions of the tube accordingly. The double sign before $\Delta\gamma_o$ indicates that autocollimation readings depends on the direction of rotation of the tube. The sign "minus" corresponds to direct or positive rotation (autocollimation readings increase).

When investigating the BVC we supposed that for the perfectly adjusted tube deflection of its ends should be also of some regular character. In such a case the autocollimation readings should exactly satisfy the equations (2). On the contrary, if the fastening of the objective lenses, micrometers details of both halfs of the cube is not sufficiently rigid, their irregular abrupt displacements results in shifts of the visual axis, and hence, in the changes of autocollimation readings of same character. This in turn affects the residuals of the equations (2).

Thus our task in Belgrad observations was to obtain the series of autocollimation readings with consecutive revolving of the tube through equal intervals of zenith distance.

Altogether we obtained six series of measurements for intervals of 30° from Z = - 90° to Z = + 90° for positive rotattion and from Z = = + 90° to Z = - 90° for opposite rotation of the tube. Zenith distance to south from zenith was taken with positive sign. Thus, for each direction of rotation we obtained three series of measurement.

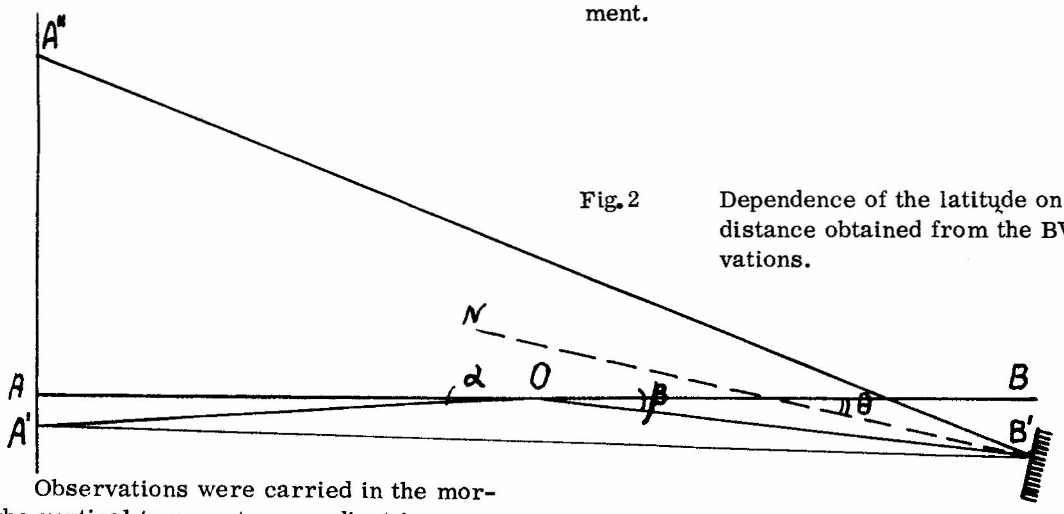


Fig. 2 Dependence of the latitude on zenith distance obtained from the BVC observations.

Observations were carried in the morning for the vertical temperature gradient is comparatively small in this hours. The roof of the pavilion was kept close. Still, as the figure 3 shows the vertical gradient was big enough ot the time of our observations. The difference between temperature near the roof and the floor of the pavilion was up to 1°C.

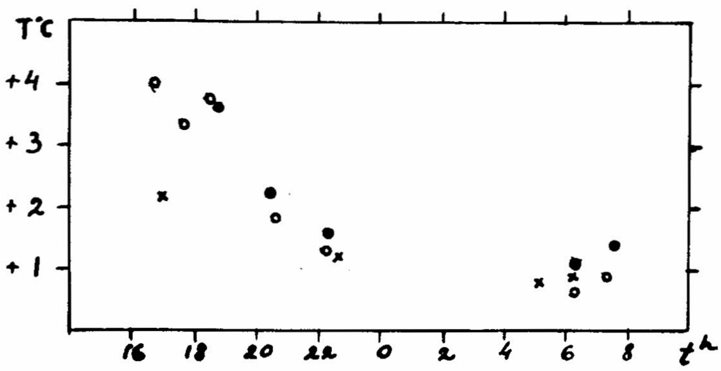


Fig.3 The vertical temperature gradient in the pavilion BVC

. . . -from measurements, 28-29 July 1969

o o o -from measurements, 29-30 July 1969

x x x -from measurements, 30-31 July 1969

Table 1

DIRECT ROTATION

Z	Set 1	Set 4	Set 6
-90^{o}	0.6595	0.6835	0.6870
-60	0.8805	0.9030	0.8895
-30	1.4420	1.4545	1.4620
0	2.1710	2.2044	2.1894
+30	2.8755	2.9100	2.9080
+60	3.4140	3.4620	3.4605
+90	3.6325	3.6550	3.6500

REVERSE ROTATION

Z	Set 2	Set 3	Set 5
$+90^{o}$	3.6415	3.6585	3.6490
+60	3.4370	3.4960	3.4810
+30	2.9065	2.9445	2.9385
0	2.2022	2.2402	2.2180
-30	1.4750	1.4890	1.4925
-60	0.8930	0.9170	0.9080
-90	0.6670	0.6725	0.6850

Table 1 shows autocollimation readings for all the six series. Each of the series permitted 7 equations of type (2) to be composed. The solution of these equations by the method least squares gave 6 groups of three-unknowns $A_o, \gamma_o, \Delta\gamma_o$ listed in table 2. Table 3 gives 6 series residuals obtained after substitution of the values of these unknowns into the equations. As one can see from table 3, the residuals proved to be essentially larger than those for the Wanshaff vertical circle and moreover were not of random character.

Table 2

SOLUTIONS OF THE EQUATIONS (2)

Set	A_o	γ_o	$\Delta\gamma_o$
1	2.1430	1.4710	-0.0199
2	2.1503	1.4734	+0.0455
4	2.1690	1.4789	-0.0240
3	2.1697	1.4856	+0.0630
6	2.1674	1.4782	-0.0201
5	2.1674	1.4788	+0.0537

For the analysis of these errors the so called model method was used. It consists in searching such physically possible imaginary motions of the line of vision which residuals fit with the obtained from observations.

Table 3

OBSERVED RESIDUALS

Direct rotation

Z	Set 1	Set 4	Set 6	Mean
-90^{o}	-25	-13	- 4	-14
-60	+ 3	+ 5	-16	- 3
-30	+35	+ 8	+32	+25
0	+16	+23	+ 4	+14
+30	-40	-38	-32	-37
+60	-26	+ 1	+ 6	- 6
+90	+37	+14	+ 9	+20
Σv^2	5760	2428	2453	2831

Reverse rotation

Z	Set 2	Set 3	Set 5	Mean
$+90^{o}$	+36	+ 6	+ 6	+16
+60	-24	+16	+12	+ 1
+30	-40	-45	-29	-38
0	+13	+15	- 6	+ 7
-30	+44	+15	+36	+32
-60	- 8	+ 5	-11	- 5
-90	-20	-13	- 7	-13
Σv^2	6041	2961	2523	2968

Let us take one of the set of observations and substitute into the equations (2) for this set the values of $A_o, \gamma_o, \Delta\gamma_o$ obtained by the least square method from the same equations. The value of the right parts of the equations so obtained we denote l_z^c (Z : $\pm 90^o, \pm 60^o$ ...). If these l_z^c coincide with the autocollimation readings A_z the tube adjustment could be regarded as a perfect one in accordance with the assumption made earlier.

Let us assume now that the objective lenses attachment loosed and 2k is the value of largest possible displacement of the lenses and of the rear nodal point in the cell. When the tube is in horizontal position the lenses under the action of their weight should occupy the extreme position in the cell. Evidently they will remain in this position untill the tube being rotated by zenith distance passes through the zenith. Then after the component of the force of gravity will exceed the force of the friction, lenses will shift to another extreme position in the cell. They will remain in that position untill the tube again turn through zenith in opposite direction.

In such a case when rotation of the tube is positive the right part of the equations (2) for the first four zenith distances (-90^o, -60^o, -30^o, 0^o) will be increased and must be written as

$$l_z^c + k$$

For three further settings of the tube, Z: + 30°, + 60°, + 90°, these right parts must be decreased, i.e. expressed as

$$l_z^c - k$$

For reverse rotation of the tube the right parts of equations must be increased (l_z^c - k) for four settings Z : + 90°, + 60°, + 30°, 0° and decreased (l_z^c + k) for three further ones Z : -30°, -60°, - 90°

Solving such systems and substituting new solutions instead of unknowns, one can obtain the residuals corresponding to described model of the line of vision displacements that will be named further as "model 1". Let us name such deviations as "standard" unlike original ones that will be named further as "observed". Similar standard deviations can be also obtained for the slack model of eyepiece micrometer of autocollimation mirror. For the latter change of angle γ_o, as it is seen from the equation (1) has an opposite sign for the same direction of rotation of the tube.

Table 4

"STANDARD" RESIDUALS FOR MODEL 1, k=0.01

Direct rotation

Z	Micrometer slack δ_i^{α}	Lenses slack δ_i^{β}
-90°	+ 2	- 2
-60	+ 3	- 3
-30	- 2	+ 2
0	-13	+13
+30	+15	-15
+60	+ 2	- 2
+90	- 6	+ 6

Reverse rotation

Z	Micrometer slack δ_i^{α}	Lenses slack δ_i^{β}
+90°	- 2	+ 2
+60	- 3	+ 3
+30	+ 2	- 2
0	+13	-13
-30	-15	+15
-60	- 2	+ 2
-90	+ 6	- 6

Table 4 gives the "standard" deviations obtained for k = 0,01 and for four models, two of which correspond to lenses slack (change of angle β) and two - to micrometer and autocollimation mirror slack (change of angles α and θ).

Comparing "observed" deviations with "standard" ones we can conclude that the model with slack of the lenses (model 1) is in agreement with observed deviations.

It was not difficult to find values of k' for every observed set so that its "standard" residuals correspond to the observed ones in the best manner in the sense of the least square method. Let now Δ_o be observed residuals and Δ_c calculated ones; then this condition may be written as

$$\Sigma(\Delta_o - \Delta_c)^2 = \min$$

The optimum k' may be find with help of the formule

$$k' = \frac{\Sigma \Delta_o \delta_i}{\Sigma \delta_i^2} \qquad (3)$$

where $\Delta_c = \delta_i$ are given in table 4 for k = 0, 01, and corresponding optimum standard residuals may be obtained as

$$\Delta_c = k' \cdot \delta_i$$

Table 5

OPTIMUM "STANDARD" RESIDUALS FOR MODEL 1

Direct rotation

Z \ k'	Set 1	Set 4	Set 6	Mean
	2.7	2.2	1.6	2.2
-90°	- 4	- 4	- 3	- 4
-60	- 8	- 7	- 5	- 7
-30	+ 6	+ 5	+ 4	+ 5
0	+35	+29	+21	+28
+30	-38	-31	-23	-31
+60	- 5	- 4	- 3	- 4
+90	+15	+13	+ 9	+12

Reverse rotation

Z \ k'	Set 2	Set 3	Set 5	Mean
	1.5	0.6	1.7	1.3
+90°	+ 2	+ 1	+ 3	+ 2
+60	+ 4	+ 2	+ 5	+ 4
+30	- 3	- 1	- 4	- 3
0	-19	- 8	-22	-16
-30	+21	+ 9	+24	+18
-60	+ 3	+ 1	+ 3	+ 2
-90	- 9	- 4	-10	- [illegible]

The values of k' calculated from (3) and corresponding values Δ'_c are listed in table 5. Excluding the optimum standard from observed ones for the model 1, given in table 3, we shall obtain corrected residual deviations. The latter deviations presented in table 6 were divided into two groups according to the direction of rotation.

Table 6

CORRECTED RESIDUALS (MODEL 1)

Direct rotation

Z	Set 1	Set 4	Set 6	Mean
-90^{o}	-21	- 9	- 1	-10
-60	+11	+12	-11	+ 4
-30	+29	+ 3	+28	+20
0	-19	- 6	-17	-14
+30	- 2	- 7	- 9	- 6
+60	-21	+ 5	+ 9	- 2
+90	+22	+ 1	0	+ 8
Σv^2	2693	345	1357	816

Reverse rotation

Z	Set 2	Set 3	Set 5	Mean
$+90^{o}$	+34	+ 5	+ 3	+14
+60	-28	+14	+ 7	- 2
+30	-37	-14	-25	-35
0	+32	+23	+16	+24
-30	+23	+ 6	+12	+14
-60	-11	+ 4	-14	- 7
-90	-11	- 9	+ 3	- 6
Σv^2	5104	2819	1288	2282

The mean deviations for each group are also presented in Fig. 4. As one can see from that figure both groups have essentially the same character. Corrected residuals lie almost on a stright line for three first settings of the tube before zenith. Near zenith the jump takes place; after that residuals go on a stright line again, but the angle of inclination of this line is diminished. To explain this fact we have to suppose that there exist still one displacement of the lenses in the cell, but it takes place just before the tube passes zenith. That jump takes place in the zenith distance zone from -30^{o} to 0^{o} during the positive rotation and in zone from $+30^{o}$ to 0^{o} during the reverse rotation of the tube.

Fig.4 -mean residuals of the equations (2) for direct rotation of the tuե (a), and reverse rotation of the tube (b),

1 -observed residuals,

2 -observed residuals corrected for model 1,

3 -observed residuals corrected for models 1 and 2.

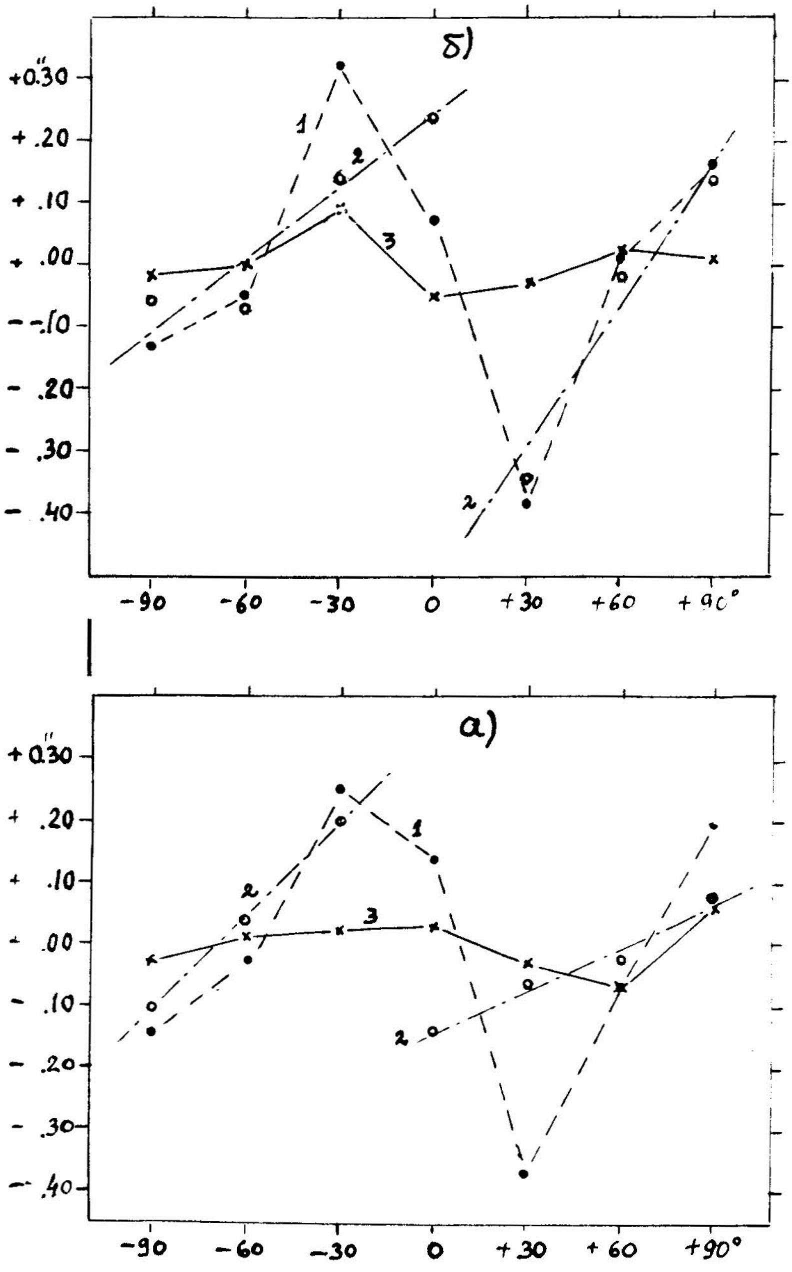


Table 7

"STANDARD"RESIDUALS FOR MODEL 2, k"=0.01

Direct rotation

Z	δ_i
-90°	- 6
-60	+ 2
-30	+14
0	-13
+30	- 2
+60	+ 3
+90	+ 2

Reverse rotation

Z	δ_i
+90°	+ 6
+60	- 2
+30	-14
0	+13
-30	+ 2
-60	- 3
-90	- 2

To find "standard" residuals for this new model of the jump of sight line, which can be named as model 2, we must increase calculated values of 1_z^c by value of k" for zenith distance : - 90°, - 60°, - 30°, and decrease then by the same quantity for setting : 0°, +30°, +60°, +90° for positive rotation, and the contrary - decrease for the first three settings : +90°, +60°, +30°, and increase for four consequent ones: 0°, -30°, -60°, -90° for reserve rotation of the tube. Substituting above mentioned values $1_z^c \pm k$ instead of observed A_z in right part of the equations (2) for k = = 0.01 we obtained "standard" residuals for model 2 listed in table 7.

Using the formule (3) just as in the first case, we shall find k" satisfying in the best manner the residuals given in table 6. These meanings of k" and corresponding optimum standard deviation for the model 2 are given in table 8. Now if we exclude these standard deviations, we shall obtain twice corrected residuals listed in table 9. This table and Fig 4 show that twice corrected deviations are comparatively not so great and may be explained as due to effect of some neglected factors: personal error, parallax, unexcluded temperature tube deformation and accidental errors of observation.

Table 8

OPTIMUM "STANDARD" RESIDUALS FOR MODEL 2

Direct rotation

	Set 1	Set 4	Set 6	Mean
Z\k"	1.8	0.5	1.5	1.3
-90°	-11	- 3	- 9	- 7
-60	+ 4	+ 1	+ 3	+ 3
-30	+26	+ 8	+22	+18
0	-24	- 7	-20	-17
+30	- 4	- 1	- 3	- 3
+60	+ 6	+ 2	+ 5	+ 4
+90	+ 3	+ 1	+ 2	+ 2

Reverse rotation

	Set 2	Set 3	Set 5	Mean
Z\k"	3.1	2.2	1.5	2.3
+90	+18	+13	+ 9	+13
+60	- 6	- 4	- 3	- 5
+30	-43	-31	-21	-32
0	+40	+29	+19	+29
-30	+ 7	+ 5	+ 3	+ 5
-60	- 9	- 7	- 4	- 7
-90	- 5	- 4	- 2	- 4

Table 9

CORRECTED RESIDUALS (MODEL 1 AND 2)

Direct rotation

Z	Set 1	Set 4	Set 6	Mean
-90°	-10	- 6	+ 8	- 3
-60	+ 7	+11	-14	+ 1
-30	+ 3	- 5	+ 6	+ 2
0	+ 5	+ 1	+ 3	+ 3
+30	-25	+ 3	+ 4	- 6
+90	+19	0	- 2	+ 6
Σv^2	1173	256	361	104

Reverse rotation

Z	Set 2	Set 3	Set 5	Mean
+90°	+16	- 8	- 6	+ 1
+60	-22	+18	+10	+ 3
+30	+ 6	-13	- 4	- 3
0	- 8	- 6	- 3	- 5
-30	+16	+ 1	+ 9	+ 9
-60	- 2	+11	-10	0
-90	- 6	- 5	+ 5	- 2
Σv^2	1136	740	362	129

Correctness of the assumed models is confirmed by the essential decrease of Σv^2 after introducing each correction. Values of Σv^2 are given in the last lines of tables 3, 6, 9.

Summarizing one can conclude that observed residual deviations may be well explained by the two displacements of rear modal point of the objective discussed above.

As the flexure is determined as

$$\Delta Z = \frac{1}{2}(\alpha - \beta)$$

the value of its change caused by the two displacements of the rear nodal point can be obtained from the expression

$$\Delta\Delta Z = -\frac{1}{2}(\Delta_1 + \Delta_2)$$

where Δ_1 and Δ_2 are values of change of the angle β due to displacements of the nodal point. They can be found for every set with help of mean values of k' and k''.

$$\Delta_{1,2} = \frac{1}{6}\sum k_i$$

Substituting values k', k'' listed in tables 5, 7 into this formule we can find

$$\Delta_1 = 0''34 \quad , \quad \Delta_2 = 0''36$$

and common change of the flexure will be

$$\Delta \Delta Z = -0''35$$

Now we can show that the disagreement in north and south star observations detected by the Belgrad astronomers is explained just by an error appearing because of the displacement of the rear nodal point.

Let Δ_0 be a correction to observed zenith distances for error in the sight line position which is to appear when the rear nodel point displaces down as a result of displacement of objective lenses under the force of gravity as it was assumed in the models 1 and 2. Evidently if zenith distances are assumed to be positive in both sides from the zenith, this correction also must be positive.

Now if Z^1_N and Z^1_S are observed zenith distances, Z_N and Z_S are true ones for north and south stars accordingly, we can write the following relations;

$$Z_N = Z^1_N + \Delta_0$$
$$Z_S = Z^1_S + \Delta_0 \qquad (4)$$

For the true zenith distances and latitude φ the following relations can be written

$$\varphi = \delta_N - Z_N$$
$$\varphi = \delta_S + Z_S \qquad (5)$$

where δ_N, δ_S are apparent declinations of north and south stars accordingly.

If φ'_N, φ'_S are observed latitudes which can be written as

$$\varphi'_N = \delta_N - Z'_N$$
$$\varphi'_S = \delta_S + Z'_S$$

then after substituting these expressions and values Z_N, Z_S from (4) into (5) we can write.

$$\varphi'_N = \varphi + \Delta_0$$
$$\varphi'_S = \varphi - \Delta_0 \qquad (6)$$

Hence, the latitudes obtained from the north stars should be increased and from the south stars - decreased by the same value Δ_0 just as it occured in observations at the BVC. The value Δ_0 as it is seen from the above results of 227 north and south star observations must be equal to

$$\Delta_0 = 0''39$$

This value practically coincides with the error for flexure obtained from our investigations ($\Delta\Delta Z = 0''35$).

As a result of all the above discussion one can conclude that anomalous changes of sight line position are observed for the BVC when the tube is rotated through the zenith.

These changes are caused anomalous slack type displacement of the rear nodal point of the objective. The value and characters of these displacements obtained from the analyses of autocollimation measurements explain well the disagreement in latitudes to be obtained from the observations of the north and south stars.

To remove this defect in adjustment of the tube it is necessary to pay attention to reliability of fastening of the objective lenses in the cell and also to attachment of the objective itself to the tube that may be also a cause of slack of the rear nodal point.

In closing I wish to give my thanks to N. Kravljanac, mechanic and B. Kubičela, calculator, who helped me very much in my research at the Belgrad Observatory. I also express my deep gratitude to Dr. G. Teleki who take upon himself all organization part of this work and the correspondent member of the Academy of Sciences of the USSR M. S. Zverev, by whose initiative this work was undertaken.

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BELGRADE LARGE VERTICAL CIRCLE EXAMINATION

BY AUTOCOLLIMATIONAL METHOD

G. Teleki

1. The first works with the large vertical circle (Askania 190/2578 mm) at Belgrade Astronomical Observatory indicated already that the instrument used at that time could not give results of needed preciseness [1] . Later-on, certain corrections were done on the instrument, the results were somewhat better, but the observational results had not reached the needed level of preciseness. The analysis of the last series of stars observation [2] brought about the following results: the mean accidental error of one observation was $\pm 0''.64$; the mean systematical error of a north star was $\pm 1''.13$, and of a south star was $\pm 0''.76$; latitude carried out of north stars observations was $0''.78$ bigger than latitude obtained by south stars. Studiing all these results, in [2] it was evident that the main sources for systematical and accidental observational errors were connected with horizontal and vertical axes. The importance that the horizontal axis has pivots of regular form and bearings that may secure steady position, was specially stressed.

Before any start to eliminate these mechanical imperfectnesses, we were of the attitude to discover some other possible sources of disturbance. While we were discovering such imperfectnesses, Dr. A. S. Harin (Main Astronomical Observatory, Academy of Science of Ukrainian S. S. R. , Kiev-Golosejevo) drew our attention to the possible influence of anomalous displacement of the rear nodal point of the objective. When the telescope tube is passing over the zenith, an anomalous change may occur in the position of sight line due to badly fixed objective, micrometric parts or tube parts connected with the central tube parts.

A. S. Harin suggested the use of autocollimational method for this kind of examination. He was so kind accepting to produce for us a corresponding mirror and to start with examinations himself. He stayed in Belgrade in July 1969 and helped us at the start of these examinations, so we take this opportunity, also, to thank him again for the kindness extended to us.

A flat mirror of 40 mm diameter and 7 mm thickness, possessing good characteristics, mounted on a duraluminium disc (diameter 220 mm and thickness 5 mm) fixed to the outer side of the frame which held the objective. At the first time, the autocollimational ocular produced by Lj. Paunović was used, but later, from 22nd series, Gauss-ocular was used. The change of ocular was due to the fact that Paunović-ocular was unable to eliminate the parallax of the thread.

Micrometric double thread was used for these measurements. One of the threads was conducted to the middle of the reflected image, and after that followed the micrometric reading. Then, the same action was repeated with the second thread (at the series with ordinal numbers from 1. to 8., each autocollimational reading recorded one measurement with each thread, at first, and later it recorded two measurements). Out of these readings the mean value has been carried out what is marked here with A_z. As per Harin [3] , the value A_z can be represented in the following way:

$$A_z = A_o + \gamma_o \sin z \pm \Delta\gamma_o \cos z \qquad (1)$$

where : A_o - micrometer zero point, which can be interpreted as an autocollimational reading for an ideal, undeformed tube,

γ_o - autocollimational angle of horizontal tube position,

$\Delta\gamma_o$ - autocollimational angle of vertical tube position,

z - zenith distance; it is for the south position positive.

The double sign before $\Delta\gamma_o$ shows dependance of the tube rotation direction. At the direct rotation, when autocollimational reading is increasing, the minus is used and plus is used in viceversa direction. Such law was maintained when the large vertical circle in Kiev-Golosejevo was examined.

The autocollimational angle itself γ, as per [4], may be represented as follows:

$$\gamma = \alpha - \beta + 2\theta \qquad (2)$$

where: α - angle of flexure of the ocular tube part,

β - angle of flexure of the objective tube part,

θ - angle of changed mirror position towards the sight line of an ideal, undeformed tube.

In the practice instead of angle γ we have A_z, what is represented by expression (1).

Accordingly, the method suggested by Harin has not offered possibilities for determination of tube flexure (values $\alpha - \beta$), but a joint effect is obtained, from which by expression (1) we are able to analyse mechanical deformations of the tube. Indications that this is correct can be found in the examinations done by Harin in Kiev as well as in Hansson's paper [5]. Hansson, also, used the mirror in front of the objective, autocollimational reading was recorded at various zenith distances, but he did not carry out conclusions analysing the data received by the expression (1).

2. Autocollimational measurements from horizon to horizon by 30° rotation

The first group of measurements included series of autocollimational measurements from horizon to horizon with 30° rotation at the zenith distances. The proceeding was the following: The tube was directed, say to $z = +90^o$, where autocollimational reading was recorded, then the tube was directed at $z = +60^o$, and A_z was noted. the proceeding is continued in that way until $z = -90^o$ was reached. Then, the measurement was repeated but this time from $z = -90^o$. When the tube was directed to the zenith double autocollimational reading was effected - feet towards the north and feet towards the south - and finally, the mean value was obtained out of that. Accordingly, one series of measurements gave 14 values of A_z. Between each two tube positions in succession, passed 2-3 minutes, at least, and starting from 28th series, 10-15 minutes.

Using the expression (1), A_o, γ_o and $\Delta\gamma_o$ were determined by the method of least squares.

Table 1 indicates the basic data obtained at this group of measurements. In the column "tube rotation direction" a notes order when the measurements started with $z = +90^o$ while b notes the measurements which started with $z = -90^o$. Data A_o, γ_o and $\Delta\gamma_o$ are given in the units of the value of a revolution of the micrometer screw (R).

Value ε (in seconds of arc) is:

$$\varepsilon \sqrt{\frac{\Sigma \Delta^2}{n-1}} \qquad (3)$$

where: $\Delta = (A_z - A_{zc})R$

A_{zc} - calculated value A_z as per expession (1),

n - number of conditioned equation (n = 14),

R - mean value of a revolution of micrometer screw (=20").

The point was to gather as much as possible of effected measurements to be able to judge on the variability of the obtained results. The measurements were conducted by: Harin (H), Teleki (T) and Kubičela (K). We have 43 series in various combinations - with unprotected tube. Finding that the large vertical temperature gradient in the pavilion was too high from time to time (sometimes over 1^o C/m) we decided to protect the tube, though partly only. The protection was done by double sheets of aluminium folio. The micrometer was also protected, but not completely, because of its movable parts. 14 series have been gathered under these conditions.

The basic results of these measurements are given in Table 1 and in Fig. 1. A remark on it would be: value γ_o has a contra sign depending on the instrument position - position in the east is always negative, and in the west it is always positive. Therefore, it is preferable to introduce in (1) the double sign before γ_o sin z. We shall always talk about the absolute value γ_o, because it has been so represented in Fig. 1.

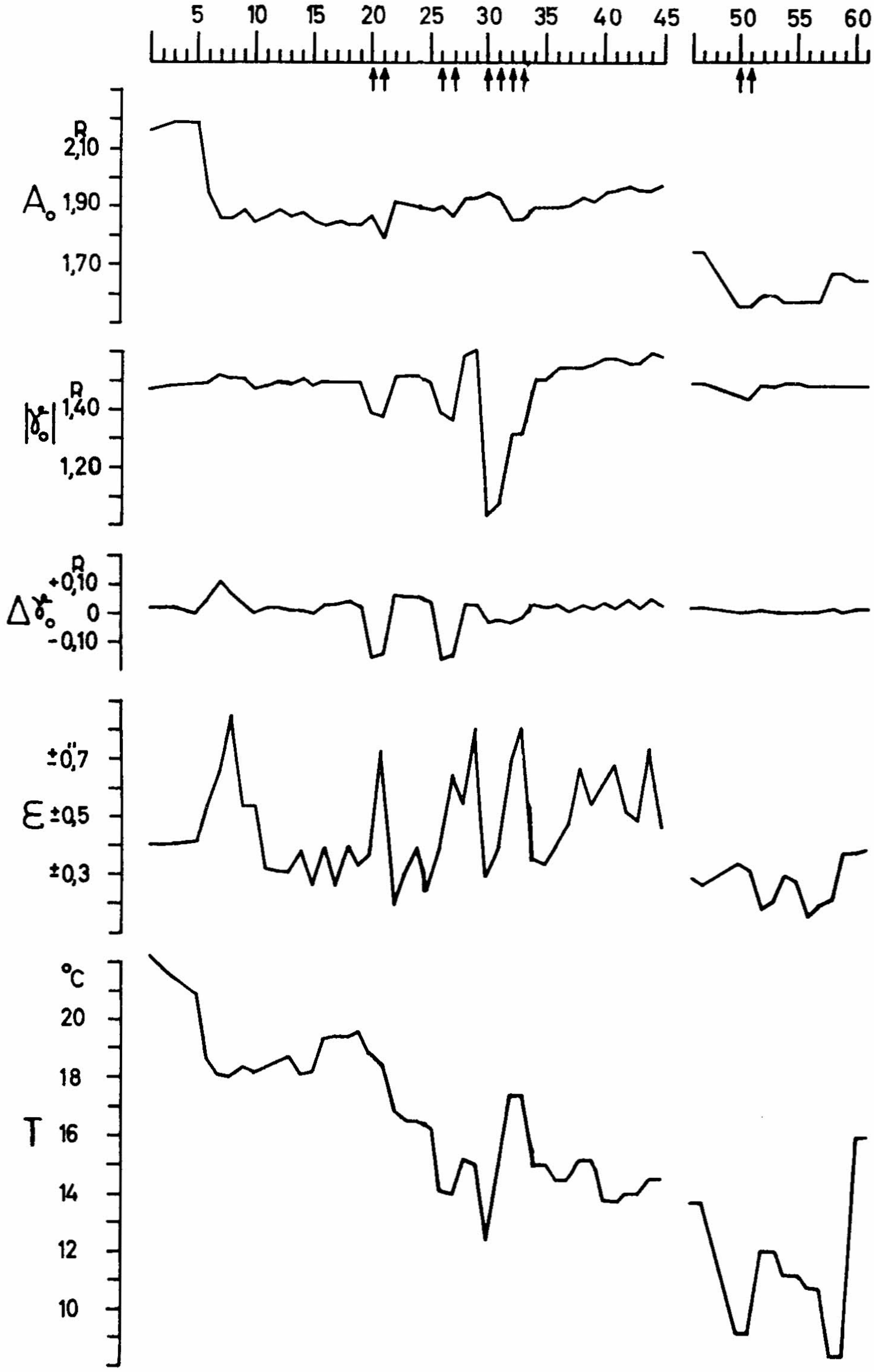

FIG.1.

Values A_o, $|\gamma_o|$, $\Delta\gamma_o$ (all in units of R, the value of a revolution of the micrometer screw), $\mathcal{E}$ (in seconds of arc) and mean air temperature (T) in ^{o}C, as per Table 1. Arrows at the markation for the number of series are noting that the examination on that day are done at open dome. With series 46-41 the tube was protected by aluminium folio.

T A B L E 1.

Number of series	Instru-ment position.	D a t e	Air temperature (in ^{o}C)	Observer	Tube rotation direction	A_o (in R)	γ_o (in R)	$\Delta\gamma_o$ (in R)	ε (in sec. of arc)	Dome
				Unprotected tube						
1.	W	29. VII. 1969.	+ 22°,2	H	b	2,1641	+1,4721	+0,0174	±0",40	
3.	W	30. VII. 1969.	+ 21,5	H	a	2,1925	+1,4822	+0,0199	0,40	
5.	W	31. VII.1969.	+ 20.9	H	a	2,1870	+1,4785	+0,0017	0,41	
6.	W	26. VIII. 1969.	+ 18,7	T	a	1,9510	+1,4918	+0,0469	0,54	
7.	W	9. IX. 1969.	+ 18,1	T	a	1,8676	+1,5190	+0,1129	0,66	
8.	W	"	+ 18,0	T	a	1,8575	+1,5105	+0,0688	0,85	
9.	W	11. IX. 1969.	+ 18,4	T	a	1,8926	+1,5148	+0,0384	0,53	
10.	W	13. IX. 1969.	+ 18.2	K	a	1,8486	+1,4724	+0,0021	0,54	
11.	E	"	+ 18,3	K	a	1,8683	-1,4801	+0,0158	0,32	
12.	E	"	+ 18,5	T	b	1,8875	-1,4976	+0,0174	0,31	
13.	W	"	+ 18,7	T	b	1,8704	+1,4872	+0,0099	0,31	
14.	E	14. IX. 1969.	+ 18,1	T	b	1,8768	-1,5100	+0,0110	0,38	
15.	W	"	+ 18,2	T	b	1,8464	+1,4932	+0,0022	0,27	
16.	W	15. IX. 1969.	+ 19,3	K	a	1,8436	+1,5050	+0,0347	0,39	
17.	W	"	+ 19,4	T	b	1,8490	+1,5037	+0,0272	0,27	
18.	E	"	+ 19,4	K	a	1,8389	-1,4995	+0,0362	0,40	
19.	E	"	+ 19,6	T	b	1,8414	-1,4976	+0,0194	0,33	
20.	E	16. IX. 1969.	+ 18,8	K	b	1,8686	-1,3940	-0,1518	0,37	open
21.	E	"	+ 18,5	T	a	1,8046	-1,3840	-0,1428	0,73	open
22.	E	22. IX. 1969.	+ 16,9	K	a	1,9182	-1,5188	+0,0735	0,20	
23.	E	"	+ 16,6	T	b	1,9069	-1,5164	+0,0658	0,31	
24.	W	"	+ 16,5	K	a	1.9029	+1,5159	+0,0647	0,39	
25.	W	"	+ 16,3	T	b	1,8896	+1,4969	+0,0446	0,25	

26.	W	24. IX. 1969.	+ 14, 1	K	a	1, 9032	+1, 3978	-0, 1638	0, 41	open
27.	E	"	+ 14, 0	K	a	1, 8711	-1, 3725	-0, 1404	0, 65	open
28.	E	26. IX. 1969.	+ 15, 2	T	b	1, 9298	-1, 5914	+0, 0265	0, 55	
29.	E	27. IX. 1969.	+ 15, 0	T	a	1, 9293	-1, 6133	+0, 0348	0, 81	
30.	E	29. IX. 1969.	+ 12, 4	T	a	1, 9526	-1, 0442	-0, 0331	0, 29	open
31.	E	30. IX. 1969.	+ 14, 8	T	b	1, 9342	-1, 0754	-0, 0220	0, 39	open
32.	E	1. X. 1969.	+ 17, 4	T	b	1, 8651	-1, 3176	-0, 0318	0, 69	open
33.	W	"	+ 17, 4	T	a	1, 8648	+1, 3193	-0, 0133	0, 81	open
34.	E	2. X. 1969.	+ 15, 0	T	b	1, 9046	-1, 5080	+0, 0289	0, 36	
35.	W	"	+ 15, 0	T	a	1, 8997	+1, 5126	+0, 0240	0, 34	
36.	W	3. X. 1969.	+ 14, 5	T	b	1, 9026	+1, 5481	+0, 0301	0, 40	
37.	E	"	+ 14, 5	T	a	1, 9103	-1, 5468	+0, 0086	0, 47	
38.	E	6. X. 1969.	+ 15, 2	T	a	1, 9265	-1, 5545	+0, 0272	0, 67	
39.	W	"	+ 15, 2	T	b	1, 9207	+1, 5562	+0, 0209	0, 55	
40.	W	9. X. 1969.	+ 13, 8	T	b	1, 9511	+1, 5761	+0. 0377	0, 62	
41.	E	"	+ 13, 8	T	a	1, 9579	-1, 5782	+0, 0240	0, 68	
42.	E	10. X. 1969.	+ 14, 0	T	b	1, 9674	-1, 5741	+0, 0462	0, 52	
43.	W	"	+ 14, 0	T	a	1, 9637	+1, 5749	+0, 0253	0, 49	
44.	W	11. X. 1969.	+ 14, 5	T	a	1, 9641	+1, 6018	+0, 0536	0, 74	
45.	E	"	+ 14, 5	T	b	1, 9792	-1, 5916	+0, 0287	0, 47	

Protected tube

46.	E	20. X. 1969.	+ 13, 7	T	b	1, 7483	-1, 5015	+0, 0204	0, 29	
47.	W	"	+ 13, 7	T	a	1, 7485	+1, 5018	+0, 0200	0, 27	
50.	E	27. X. 1969.	+ 9, 2	T	a	1, 5706	-1, 4584	+0, 0066	0, 34	open
51.	W	"	+ 9, 2	T	b	1, 5724	+1, 4547	+0, 0108	0, 32	open
52.	E	28. X. 1969.	+ 12, 0	T	b	1, 5960	-1, 4876	+0, 0203	0, 19	
53.	W	"	+ 12, 0	T	a	1, 5976	+1, 4896	+0, 0134	0, 22	
54.	W	30. X. 1969.	+ 11, 2	T	b	1, 5799	+1, 5001	+0, 0134	0, 30	
55.	E	"	+ 11, 2	T	a	1, 5820	-1, 5018	+0, 0119	0, 28	
56.	W	3. XI. 1969.	+ 10, 8	T	a	1, 5775	+1, 4931	+0, 0144	0, 16	
57.	E	"	+ 10, 8	T	b	1, 5798	-1, 4941	+0, 0132	0, 20	
58.	E	9. XI. 1969.	+ 8, 4	T	b	1, 6712	-1, 4924	+0, 0174	0, 22	
59.	W	"	+ 8, 4	T	a	1, 6729	+1, 4867	+0, 0095	0, 38	
60.	W	13. XI. 1969.	+ 16, 0	T	a	1, 6519	+1, 4920	+0, 0182	0, 38	
61.	E	"	+ 16, 0	T	b	1, 6537	-1, 4943	+0, 0185	0, 39	

Beside the characteristics shown in Table 1, we are introducing another two ones : 1/we are taking mean value from ε out of a number of series with the markation ε_s:

$$\varepsilon_s = \sqrt{\frac{\Sigma \varepsilon^2}{N}}$$

where N represents number of series, and 2/ for each tube position we are carrying out a range(d), difference between the maximal and minimal value of Δ in different series, and according to that we are calculating:

$$d_s = \frac{\Sigma d}{n}$$

where $\underline{n}$ (= 14) notes number of tube positions in a series.

The results are indicating that all values are variable in a smaller or bigger extend, clearly speaking about certain unsteadiness of the optical unity. Beside this general remark, there are some others that are worth of mentioning:

a) It is an important constatation that A_0 is a variable value regardless of the fact whether the tube was protected or not.

In Fig. 1 we can see the tendency of change of A_0 in the function of air temperature. The correlation coefficient between A_0 and air temperature for unprotected tube is +0,16 and for protected tube is + 0,39. If, however, we reject values A_0 out of series 1, 3, 5 and 6 (three measurements by Harin and one by-Teleki - carried out before the systematical gathering of autocolimational measurements) then for the correlation coefficient between A_0 for unprotected tube and air temperature we are getting a very high value of -0,83. That A_0 is changing according to the time, being in good correlation with air temperature, is considered as quite real. The fact that the tube protection changes to some extend the character of A_0, must not be neglected, but the changeability of this value still stays. It is taken as very important because A_0 is a kind of stability predicator of micrometer zero point.

b) Absolute value of γ_0 is very changeable when the tube was not protected, but its value can be well stabilized by the protection of tube. The most striking changes are recorded at the open dome. In that state with protected tube, the changes are strikingly less.

c) With unprotected tube the sign of $\Delta\gamma_0$ changes when dome is open. This fact as well as the one under point b) speaks that the measurements effected at the closed dome cannot be taken as characteristical for the cases when the instrument was in the open. When the tube us protected, the changes of $\Delta\gamma_0$ are small, and when the dome is open thereare no changes of sign.

d) As Table 2 indicates, it is characteristical that values $\Delta = (A_z - A_{zc})R$ are positive in vicinity of zenith while the negative ones are at bigger zenith distances. It might be taken as a systematical quality that does not change at the tube protection, as well. However, a certain disproportion of data Δ according to the zenith may be noticed - so, this problem requires more attention later-on.

e) Tube protection has caused the reduction of ε in certain series, what meant that the differences of measured A_z were reduced from the calculated ones by the expression (1). ε_s is reduced by cca 40%. The range (d) of obtained data is lessened, as well. It is clearly shown in Table 3. Let us emphasize that the mean values of series from 1. to 21., observed by Paunović-ocular, does not differ much from the data belonging to series from 22. - 45. - observed by Causs-ocular.

f) There is a certain difference of measurements between the order $\underline{a}$ and $\underline{b}$. It is seen in the Table 3. The tube protection has lessened the difference.

This group of measurements proved that the temperature influences may change qualities of the instrument. On account of that we are realising that the protection of tube done by aluminium folio acts as a kind of stabilisation.

We insisted on the continuation of these examinations with the aim to get the most precise answer to a number of questions. Because of that we mounted the thermistores to measure temperature variations on the tube. One pair was installed at the tube ends by the micrometer, and the other pair near the objective. Both thermistores in the pairs were placed at the opposite ends of the tube in its vertical section.

Beside that, by the thermistores placed in a stick, we measured air temperature differences among the heights suitable for the position of the objective and the ocular when the tube was directed towards the zenith.

The measurements up to $0\overset{\circ}{,}004$ C were abled to be carried out in all the three cases. Markation of the thermistore pairs is the following: air in the pavilion I, micrometric part II and objective part III.

T A B L E 2.

Tube rotation direction	zenithal distance	Mean value of Δ	
		Unprotected tube	Protected tube
	+ 90°	- 0,''41	- 0,''42
	+ 60	- 0,21	+ 0,02
	+ 30	+ 0,18	+ 0,21
	0	+ 0,28	+ 0,30
	- 30	+ 0,21	+ 0,15
	- 60	+ 0,08	- 0,10
	- 90	- 0,25	- 0,24
a			
	- 90	- 0,37	- 0,24
	- 60	- 0,21	- 0,06
	- 30	+ 0,11	+ 0,20
	0	+ 0,38	+ 0,19
	+ 30	+ 0,27	+ 0,27
	+ 60	+ 0,05	+ 0,02
	+ 90	- 0,19	- 0,29
	- 90	- 0,12	- 0,44
	- 60	- 0,05	- 0,04
	- 30	+ 0,19	+ 0,26
	0	+ 0,21	+ 0,22
	+ 30	+ 0,20	+ 0,15
	+ 60	+ 0,03	- 0,01
	+ 90	- 0,31	- 0,22
b			
	+ 90	- 0,26	- 0,22
	+ 60	- 0,03	- 0,11
	+ 30	+ 0,10	+ 0,10
	0	+ 0,24	+ 0,26
	- 30	+ 0,27	+ 0,29
	- 60	- 0,10	+ 0,01
	- 90	- 0,36	- 0,23

T A B L E 3.

	Unprotected tube		Protected tube	
	ε_s	d_s	ε_s	d_s
Total of series	± 0,''50	1,''61	± 0,''29	0,''48
Rotation direction: a	± 0,56	1,98	± 0,30	0,52
Rotation direction: b	±0,43	1,24	± 0,28	0,44

T A B L E 4.

Number of series	Instrument position	Date	Air temperature (in ^{o}C)	Observer	Tube rotation direction	A_o (in R)	γ_o (in R)	$\Delta\gamma_o$ (in R)	ε (in sec. of arc)
				Unprotected tube					
90.	E	26. XII. 1969	0°,0	T	a	2,5129	-1,4518	+0,0069	+0″,32
91.	E	"	0,0	T	a	2,5129	-1,4497	+0,0070	0,31
92.	W	29. XII. 1969.	+0,2	T	b	2,5047	+1,4478	+0,0123	0,27
93.	W	"	+0,2	T	b	2,5054	+1,4545	+0,0083	0,28
94.	E	30. XII. 1969.	+0,2	T	b	2,4999	-1,4531	+0,0104	0,19
95.	E	"	+0,2	T	b	2,4995	-1,4519	+0,0087	0,23
96.	E	16. I. 1970.	+7.4	T	a	2,4134	-1,5140	+0,0386	0,25
97.	W	"	+7.4	T	b	2,4127	+1,5135	+0,0377	0,25
98.	E	6. II. 1970.	+7.6	T	b	2,3610	-1,5332	+0,0461	0,34
99.	W	"	+7,6	T	a	2,3609	+1,5309	+0,0426	0,34
100.	W	10. II. 1970.	+7,4	T	a	2,3405	+1,5240	+0,0386	0,29
101.	W	"	+7,4	T	a	2,3417	+1,5260	+0,0365	0,27
				Protected tube					
80.	E	12. XII. 1969.	+2.6	T	a	2,5148	-1,4704	+0,0122	0,27
81	W	"	+2,6	T	b	2,5135	+1,4717	+0,0120	0,28
82.	E	15. XII. 1969.	+2,6	T	b	2,5067	-1,4715	+0,0133	0,22
83.	W	"	+2,6	T	a	2,5060	+1,4734	+0,0108	0,21
84.	E	16. XII. 1969.	+2,4	T	a	2,5060	-1,4726	+0,0094	0,25
85.	W	"	+2,4	T	b	2,5052	+1,4722	+0,0095	0,26
86.	E	19. XII. 1969.	+2,6	T	b	2,4975	-1,4692	+0,0113	0,23
87.	W	"	+2,6	T	a	2,4975	+1,4684	+0,0110	0,24
88.	E	22. XII. 1969.	-0,4	T	a	2,5206	-1,4644	+0,0069	0,22
89.	W	"	-0,4	T	b	2,5206	+1,4651	+0,0066	0,26
104.	E	22. II. 1970.	+0,3	T	b	2,4607	-1,4663	+0,0164	0,21
105.	W	"	+0,3	T	a	2,4596	+1,4682	+0,0137	0,18

TABLE 5.

Positions	δA_z (in R)				$\delta\Delta$ (in sec. of arc)			
	Unprotected tube		Protected tube		Unprotected tube		Protected tube	
	E	W	E	W	E	W	E	W
75-75	-0.0230	-0.0091	-0.0084	-0.0070	-0.″46	-0.″18	-0.″17	-0.″14
60-60	- 447	- 385	- 311	- 327	- 71	- 57	- 52	- 56
45-45	- 387	- 347	- 376	- 369	- 42	- 30	- 56	- 54
30-30	- 359	- 408	- 235	- 277	- 22	- 27	- 20	- 29
15-15	- 344	- 315	- 223	- 218	- 08	+ 04	- 12	- 12
0-0	- 420	- 387	- 252	- 219	- 16	- 02	- 14	- 08
345-345	- 192	- 241	- 157	- 167	+ 32	+ 30	+ 07	+ 04
330-330	- 257	- 271	- 68	- 72	+ 16	+ 21	+ 23	+ 22
315-315	- 154	- 230	- 72	- 3	+ 30	+ 21	+ 19	+ 32
300-300	- 207	- 223	+ 27	- 22	+ 08	+ 10	+ 32	+ 21
285-285	- 170	- 251	- 7	- 25	+ 01	- 11	+ 18	+ 14
270-270	- 104	- 131	- 13	+ 37	- 03	- 06	+ 07	+ 17
255-255	-0.0073	-0.0042	+0.0011	-0.0001	-0.15	-0.08	+0.02	0.00
δA_{zs}	-0.0257	-0.0256	-0.0135	-0.0133	-0.10	-0.06	-0.05	-0.05
$\lvert \delta A_z \rvert_s$	0.0257	0.0256	0.0141	0.0139	0.24	0.19	0.21	0.22
255-255	+0.0074	+0.0095	+0.0043	+0.0043	+0.15	+0.19	+0.09	+0.09
270-270	+ 242	+ 413	+ 215	+ 187	+ 26	+ 42	+ 29	+ 25
285-285	+ 399	+ 738	+ 221	+ 234	+ 36	+ 69	+ 17	+ 23
300-300	+ 288	+ 670	+ 147	+ 144	- 04	+ 23	- 09	- 05
315-315	+ 367	+ 749	+ 179	+ 125	- 02	+ 14	- 11	- 16
330-330	+ 335	+ 718	+ 291	+ 226	- 17	- 08	+ 06	00
345-345	+ 332	+ 710	+ 163	+ 146	- 20	- 15	- 22	- 18
0-0	+ 461	+ 717	+ 326	+ 287	+ 08	- 08	+ 12	+ 12
15-15	+ 406	+ 610	+ 251	+ 210	+ 06	- 14	+ 03	+ 01
30-30	+ 310	+ 375	+ 230	+ 227	00	- 36	+ 07	+ 12
45-45	+ 253	+ 333	+ 132	+ 156	+ 07	- 12	- 01	+ 08
60-60	+ 108	+ 221	+ 43	+ 42	- 01	+ 04	- 05	- 04
75-75	+0.0111	+0.0223	+0.0057	+0.0017	+0.22	+0.45	+0.11	+0.03
δA_{zs}	+0.0284	+0.0506	+0.0177	+0.0157	+0.06	+0.09	+0.03	+0.04
$\lvert \delta A_z \rvert_s$	0.0284	0.0506	0.0177	0.0157	0.13	0.24	0.11	0.11

3. Autocollimational measurements from the horizon to horizon by 15° rotation. -

This group of measurements, as well as the former one, included series of measurements in both tube rotation directions. The observations were done when the dome was closed, either with or without the tube protection. The observer was Teleki.

Each day included always two series of measurements as follows: the tube was directed to a certain zenith distance and after 10-15^m autocolimational reading was recorded. After the following 10-15^m without any change of the zenith distance, the second autocollimational reading was recorded. These two readings were done either at the same instrument position or at the diverse position, when the instrument, after the first reading, rotated by 180°. Values measured at the ends were separated into 2 groups (the first group included the measurements done by the first reading at the mentioned zenith distance) and separately A_0, γ_0, $\Delta\gamma_0$, ε and Δ were calculated.

The table 4 shows carried out values A_0, γ_0, $\Delta\gamma_0$ and ε. It is seen that A_0 is changable regardless of the fact whether the tube was protected or not, as well as the dependance of this value on air temperature (in connection with it the jump of A_0 is specially interested in the period between 30. XII 69. and 16. I 70., as well as on 22. XII 69. when the temperature was changed). It may be noticed that γ_0 and $\Delta\gamma_0$ are depending on temperature with the unprotected tube and their tranguility at the protected tube. The jump of $\Delta\gamma_0$ of temperature variations between 30. XII 69. and 16. I 70. was of our special interest. Value ε_s with the protected tube ($\pm$ 0\".24) difers slightly from the one when the protection of tube was not done ($\pm$ 0\".28).

The mean difference between micrometrical readings at two horizontal tube positions is 2,96R ($\approx$ 59\".2). The most striking changes are in the zenith zone - between 0° - 15° of zenith distance variations are about 0,37R and in the horizon (from 75° to 90° of zenith distance) are 0,05R. This difference was slightly changed when the tube was protected (2,94R), and when the tube was not protected (2,98R), but a better systematication of data was gained when the tube was protected.

By analysing this group of autocollimational measurements the main purpose was to point out the difference in the micrometric readings at the same tube positions (at the same zenith distances). In Table 5, values δA_z are indicated. Those are the differences between the micrometric readings done in the first part of autocollimational measurements and also in the second part, at the same tube position, when the tube was brought into that position from the other direction. 75°, 60° etc., are noting the reading on the vertical graduated circle. 345° marks the zenith, while 75° and 255° of horizontal position (at E instrument position, when the objective is in direction of the south, graduated circle indicates 75°). All values in Table 5 are the averages out of 3 series of the measurements.

Right way is apparent the difference in δA_z depending on the direction of the tube rotation towards the requested position. With series whose order of measurements is 75° $\longrightarrow$ 255° $\longrightarrow$ 75°, differences are almost completely negative and at the order 255° $\longrightarrow$ 75° $\longrightarrow$ 255° are always positive, what speaks about equal influence at all times. It means that, if, for example, the measurements are done in E instrument position, when the tube is rotated to a certain zenith distance from the south direction (75°), the autocollimational readings are always smaller than when the tube is rotated from the north direction (255°). These differences are not small - with the unprotected tube they reached the average value of 0, 05R, too, what is about 1\". It can be seen, also, that the tendency of these variations is not changed either with the protected or unprotected tube, but the temperature tube protection brings about a striking reduction of the value δA_z. In table 5 mean values of δA_z(marked δA_{zs}) are given, as well as the mean values of the absolute value of δA_z (marked $|\delta A_z|_s$).

The same Table 5 contains values $\delta\Delta$ too, as the difference of the carried out values Δ in the first and second tube position, at the same zenith distance and in the same series of measurements. We see that here the tendency is not so striking as being the case with δA_z, but the most apparent in the order 75° $\longrightarrow$ 255° $\longrightarrow$ 75° is that the transit over zenith brings about certain systematical changes.

Readings by thermistore pairs II and III have given us temperature differences at the two opposite tube ends. For the same tube positions the differences of these values are formed in the same way as with δA_z and $\delta\Delta$ (the first position minus the second position). These values marked δ II and δ III were correlated with the corresponding values δA_z and $\delta\Delta$. Since the influence of both thermistore measurements should be expected, we also effected correlation with their total sums (markation δ (II + III)/ as well as well as with their differences /markation δ (II - III) /. The correlation coefficients (r) are given in Table 6.

T A B L E 6.

r in units of 0, 01

Instrument position	Unprotected tube								Protected tube							
	75° → 255° → 75°				255° → 75° → 255°				75° → 255° → 75°				255° → 75° → 255°			
	δ II	δ III	δ(II+III)	δ(II-III)	δ II	δ III	δ(II+III)	δ(II-III)	δ II	δ III	δ(II+III)	δ(II-III)	δ II	δ III	δ(II+III)	δ(II-III)
Correlation with δA_z																
E	- 5	-26	-08	-02	+61	+29	+62	+58	-64	-28	-65	-63	+26	-32	+20	+40
W	+27	- 5	+22	+25	+65	+45	+64	+63	-67	-30	-68	-67	+26	-34	+18	+35
Correlation with $\delta \Delta$																
E	-81	-48	-83	-78	-64	+13	-60	-66	-76	-32	-76	-74	-16	-08	-15	-15
W	-77	-53	-80	-77	+10	+65	+24	-13	-76	-30	-77	-77	-14	+14	-10	-18

Let us point out that with the unprotected tube, δ II reached the maximum of value 0°51 C, and δ III the value of 0°11C. With the protected tube the maximal values are reduced 3-4 times.

The dominating role belongs to the temperature regime on the micrometric tube part (thermistore II). Since the changes on the thermistore pair III are relatively small, it is very difficult to conclude whether the combination (II + III) or (II-III) is more real.

The correlation coeficients in connection with δA_z are carrying chiefly the sign of δA_z. The correlation security with the protected tube is bigger and bigger, what means that the protected tube is less exposed to the disturbing influences then when it is unprotected.

With correlation values in connection with $\delta \Delta$, effects linked with direction of rotation are striking-at 75° ⟶ 255° ⟶ 75° correlation is very high and in the other case it is very low. The protected tube in this case also give a better picture on systematical influence with clearer uniform tendency.

Two thermistore pairs are unable to show real changes occurring in the tube, which are causing the changes in the autocolimational reading. Still, we may say, with certain security, that the temperature variations on the tube have a great influence on the value of the autocolimational reading. A very big influence comes from the rotation direction of the tube - the tube conducted from one direction "carries" with itself a certain determined grade of the tube flexure, which becomes slightly deformed while the tube passes over the zenith.That "carried" flexure is probably of the temperature origin.

Aluminium folios have greatly reduced the temperature differences on the tube, but they have not eliminated them. It is understandable,as all parts of the micrometre could not be protected by aluminium folios.

The temperature field, where the instrument is placed, suffers changes during the observation. The absolute air temperature changes, but the temperature gradient in it undergoes the most changes. That couses specially sensitive changes in the movable parts of the instrument. The most sensitive part is the tube, being mostly uncovered and whose thin walls posses a small thermal inertion [6] . Change in the temperature regime causes the change of the tube characteristics and may bring about abrupt changes in the size of flexure. Therefore the demand [7] for a very precise mechanical production of a meridian instrument tubes that will be capable to gain symmetry and homogeneity of the tube walls thickness,canby understood as quite justified. Unfortunately,it may be the case that just the Belgrade vertical circle dissatisfies at that point - we must not forget that this instrument has been produced right after the World War I on account of the War reparation. But, as shown by the previous data, the size of temperature differences is not inconsiderate.

If the tube is very sensitive to the temperature influences, then it should be understood why the majority of the vertical circles cannot give satisfactory results. The observations are done in two instrument positions where the temperature regime in the tube was different, what causes, inevitably deviations that cannot be calculated. If we add to it that with the vertical circles the size of flexure is very changeable [8] , than the results of great accuracy cannot be expected from the vertical circle.

It is evident that the changed temperature regime does not influence only the tube but also the micrometer and the objective. The micrometer is neither a symmetrical body nor is the fixing of the objective symmetrical. Let us mention that the objective we posses is fixed by the three screws: when on the vertical gradual circle we read 75^o, one of the screws is in the vertical section downwards, while the other two are at the sides above it. This might have influence on autocolimational reading depending on the tube direction - at that point we do not think at a possible rocking of the objective in the frame, but at the change of objective position together with the frame due to changed temperature conditions.

The temperature changes may cause changes in the parts where the tube is linked with the central tube part and where the tubes are linking mutually and also where connection with the micrometer and the frame of objective is created. Accordingly, tightness of linking may be reduced, as that causes already the changes in the size of autocolimational reading, even in the flexure as well.

The size of the temperature gradients is different between the nights and nights either when the dome is opened [6] or closed. Therefore, it is very difficult to effect any comparisons, especially between the data carried out when the dome was opened and closed - it is indicated as well in our experiences explained under 2c.

As far as the disturbing factors are concerned, an emphasis should be given to the influence of the observer. It nas been proved that the presence of the observer beside the instrument is quite sufficient to change the moving thread position more than 0\'\'1 [5, 9] .

All above explained speaks in contribution of the tube protection, what is naturally very important. It may be granted as acceptable that the temperature factors have caused the noted changes with our autocollimational readings at the same zenith distances (at the same tube positions).

4. Autocollimational measurements through the whole circle with 30^o rotation. -

A set of autocollimational measurements with 30^o rotation has been effected through the whole circle, with an aim to emphasize, as much as possible, the systematical influences. The measurements have been done in both directions, when the tube was covered by aluminium folio and when the dome was closed. 10-15 ^{m} passed between two autocollimational readings. Two series of measurements, in two instrument positions, have been carried out in a day. All the measurements have been conducted by Teleki.

There have been 24 series of examinations in the total. One series, as before, enclosed measurements in the first and diverted direction of the tube rotation. Both in E and W instrument positions the equal number of measurements has been effected with the starts 75^o and 255^o in the both directions. We are giving in the following tables the data representing the mean values of the measurements in E and W instrument positions.

Table 7 contains values δA_z (already defined). Under 1 we are marking the first direction of rotation (in direct or retrograde direction) and under 2 we are marking the opposite direction. The value δA_z indicates the existance of systematical differences between the autocollimational reading in the same tube position depending on the direction of tube conduction - if the objective is above the horizon, the retrograde direction is always giving bigger autocollimational micrometric readings, but it is quite opposite if the objective is below the horizon. We may notice that this difference is even more important at the appearance of the difference "R-D".

Table 8 contains the difference of the autocollimational readings (marked d_*) at those tube positions that mutually differ by 180^o. According to it we can see that the smallest deviations are when the zenith distances are 0^o and 180^o, while the biggest when the tube takes a horizontal position. This undoubtedly points to the tube flexure what is due to the gravitation. It is very important to mention that the autocollimational reading gained in the zenith is always bigger from the one gained in the nadir, if the tube is conducted in the direct way. The changes d_* for the zenith and the nadir are strikingly bigger if the tube is in retrograde direction of moving. This is proved either by mean values of (d_* (marked d_{*s}), as well as the mean absolute value of d_* (marked $|d_*|_s$), which contains all measurements.

T A B L E 7.

in units of R

Direction	Positions	δA_z	Positions	δA_z
1. direct minus 2. retrograde	75º 75	-0,0239	255º255º	+0,0100
	45- 45	- 536	225-225	+ 90
	15- 15	- 463	195-195	+ 238
	345-345	- 471	165-165	+ 338
	315-315	- 288	135-135	+ 268
	285-285	- 92	105-105	+ 80
	255-255	- 154	75-75	- 59
	225-225	- 99	45-45	- 296
	195-195	+ 13	15-15	- 246
	165-165	+ 346	345-345	- 290
	135-135	+ 301	315-315	- 246
	105-105	+ 80	285-285	- 33
	75-75	-0,0005	255-255	-0,0038
	δA_{zs}	-0,0124	δA_{zs}	+0,0010
	$\lvert\delta A_z\rvert_s$	0,0237	$\lvert\delta A_z\rvert_s$	0,0158
1. retrograde minus 2. direct	75º 75º	-0,0124	255º255º	+0,0058
	105-105	- 86	285-285	+ 230
	135-135	- 199	315-315	+ 183
	165-165	- 334	345-345	+ 306
	195-195	- 304	15-15	+ 283
	225-225	- 83	45-45	+ 27
	255-255	- 8	75-75	+ 5
	285-285	+ 169	105-105	- 86
	315-315	+ 164	135-135	- 201
	345-345	+ 208	165-165	- 317
	15-15	+ 156	195-195	- 188
	45-45	+ 86	225-225	- 129
	75-75	-0,0002	255-255	-0,0038
	δA_{zs}	-0,0028	δA_{zs}	-0,0007
	$\lvert\delta A_z\rvert_s$	0,0148	$\lvert\delta A_z\rvert_s$	0,0179

T A B L E 8.

in units of R

Direction	Positions	d_*	Positions	d_*
1. direct	75°-255°	-2.9748	255°-75°	+2.9803
	45-225	-2.5789	225-45	+2.5748
	15-195	-1.4777	195-15	+1.4792
	345-165	+0.0104	165-345	-0.0140
	315-135	+1.5091	135-315	-1.5090
	285-105	+2.6018	105-285	-2.5945
	255-75	+2.9791	75-255	-2.9779
	d_{*s}	+0.0099	d_{*s}	-0.0087
	$\|d_*\|_s$	2.0188	$\|d_*\|_s$	2.0185
2. retrograde	75°-255°	-2.9940	255°-75°	+2.9758
	105-285	-2.6190	285-105	+2.6058
	135-315	-1.5680	315-135	+1.5604
	165-345	-0.0921	345-165	+0.0768
	195-15	+1.4301	15-195	-1.4308
	225-45	+2.5352	45-225	-2.5362
	255-75	+2.9663	75-255	-2.9644
	d_{*s}	-0.0488	d_{*s}	+0.0411
	$\|d_*\|_s$	2.0292	$\|d_*\|_s$	2.0215
1. retrograde	75°-255°	-2.9754	255°-75°	+2.9754
	105-285	-2.6088	285-105	+2.6148
	135-315	-1.5462	315-135	+1.5498
	165-345	-0.0712	345-165	+0.0761
	195-15	+1.4266	15-195	-1.4330
	225-45	+2.5318	45-225	-2.5431
	255-75	+2.9636	75-255	-2.9656
	d_{*s}	-0,0399	d_{*s}	+0.0392
	$\|d_*\|_s$	2.0177	$\|d_*\|_s$	2.0225
2. direct	75°-255°	-2.9642	255°-75°	+2.9699
	45-225	-2.5487	225-45	+2.5587
	15-195	-1.4726	195-15	+1.4801
	345-165	+0.0170	165-345	-0.0138
	315-135	+1.5099	135-315	-1.5114
	285-105	+2.5833	105-285	-2.5832
	255-75	+2.9638	75-255	-2.9701
	d_{*s}	+0.0126	d_{*s}	-0.0100
	$\|d_*\|_s$	2.0085	$\|d_*\|_s$	2.0125

T A B L E 9.

in units of R

Direction	Positions	D	Positions	D
1. direct	75°- 75°	+0.0043	255°-255°	+0.0024
	45-105	- 6	225-285	- 145
	15-135	+ 13	195-315	- 191
	345-165	+ 104	165-345	- 140
	315-195	+ 301	135- 15	- 107
	285-225	+ 235	105- 45	-0.0052
	D_s	+0.0115	D_s	-0.0102
	$\|D\|_s$	0.0117	$\|D\|_s$	0.0110
2. retrograde	75°- 75°	-0.0277	255°-255°	+0.0114
	105- 45	- 610	285-225	+ 268
	135- 15	- 777	315-195	+ 675
	165-345	- 921	345-165	+ 768
	195-315	- 602	15-135	+ 621
	225-285	- 228	45-105	+ 428
	D_s	-0.0569	D_s	+0.0479
	$\|D\|_s$	0.0569	$\|D\|_s$	0.0479
1. retrograde	75°- 75°	-0.0118	255°-255°	+0.0098
	105- 45	- 296	285-225	+ 380
	135- 15	- 502	315-195	+ 602
	165-345	- 712	345-165	+ 761
	195-315	- 694	15-135	+ 566
	225-285	-0.0474	45-105	+0.0337
	D_s	-0.0466	D_s	+0.0457
	$\|D\|_s$	0.0466	$\|D\|_s$	0.0457
2. direct	75°- 75°	-0.0004	255°-255°	-0.0002
	45-105	+ 124	225-285	- 21
	15-135	+ 147	195-315	- 231
	345-165	+ 170	165-345	- 138
	315-195	+ 226	135- 15	- 82
	285-225	+0.0222	105- 45	-0.0224
	D_s	+0.0148	D_s	-0.0116
	$\|D\|_s$	0.0149	$\|D\|_s$	0.0116

Table 9 contains differences of autocollimational reading (marked D) at those tube positions that are symmetrical according to the horizon (say objective 30° above and below the horizon). As a rule, it appears that the autocollimational readings are always bigger if the objective tube part is above the horizon. This table contains also the characteristics that we emphasized in Table 8.

Once more, this group of measurements indicated that there is an existence of a systematical difference depending on the direction to where the tube was directed into a certain position.

The autocollimational examinations through the whole circle on the meridian circle in Lunds were carried out by Hansson [5] . In the table 4 of his paper, the existance of the difference among the autocollimational readings depending on conducted direction to a certain zenith distance was indicated. The mean absolute value of the difference data in direct or retrograde direction was 4,5 μ what,according to [10] , of the angle value, came to 0".40.

The mean value of all $|\delta A_z|_s$ in our table 7 has resulted 0."36. Therefore, size of this difference with both instruments is very similar. According to [5] these differences must be caused by unsatisfactory mechanical qualities of the tube but not of the settings of the lens.

Let us remark that the maximal variation of the autocollimational readings at the rotation of the tube through the whole circle, in Lunds was 36" and in Beograd 60", what is strikingly bigger.

5. Autocollimational measurements of the fictive stars at $z = 30^o$. - Since in our observations of stars a systematical difference between data obtained through south and north stars observations appeared, we tried to see these differences by autocollimational measurements, immitating so the usual observational method of stars on the vertical circles. The autocollimational measurements of the fictive stars was done at 30^o zenith distance south and north from the zenith in two instrument positions. Being customary at the star observations, the tube conduction was always from different directions at two instrument positions. The observer : Teleki. Each series of measurements included 12 fictive stars, 6 from the south and 6 from the north and they followed alternatively. The tube was with and without protection and the dome was temporary open.

We take the equation (1) in this form:

$$A_z = A_o \pm \gamma_o \sin z \pm \Delta\gamma_o \cos z \qquad (4)$$

The double sign before of γ_o indicates the dependence on position of the instrument : at E γ_o is a negative value, at W it is a positive value.

Depending on the instrument position and direction of rotation, for $z = \pm 30^o$, out of (4) the following combinations are emerging:

	direction		
E,	direct,	$z=+30^o$: $A_{zEDS} = A_o - \gamma_o \sin 30^o - \Delta\gamma_o \cos 30^o$	(5)
E,	direct,	$z=-30^o$: $A_{zEDN} = A_o + \gamma_o \sin 30^o - \Delta\gamma_o \cos 30^o$	(6)
E,	retrograde,	$z=+30^o$: $A_{zERS} = A_o - \gamma_o \sin 30^o + \Delta\gamma_o \cos 30^o$	(7)
E,	retrograde,	$z=-30^o$: $A_{zERN} = A_o + \gamma_o \sin 30^o + \Delta\gamma_o \cos 30^o$	(8)
W,	direct,	$z=+30^o$: $A_{zWDS} = A_o + \gamma_o \sin 30^o - \Delta\gamma_o \cos 30^o$	(9)
W,	direct,	$z=-30^o$: $A_{zWDN} = A_o - \gamma_o \sin 30^o - \Delta\gamma_o \cos 30^o$	(10)
W,	retrograde,	$z=+30^o$: $A_{zWRS} = A_o + \gamma_o \sin 30^o + \Delta\gamma_o \cos 30^o$	(11)
W,	retrograde,	$z=-30^o$: $A_{zWRN} = A_o - \gamma_o \sin 30^o + \Delta\gamma_o \cos 30^o$	(12)

Indexes of A_z are marking the instrument position (E, W), direction of the tube rotation (D-direct, R-retrograde) and the star position (S--south, N-north).

In the first group of our measurements north fictive stars were observed in the order ER--WD, while the south stars in the order WR-ED. Out of the equations (8) and (10), respectively (11) and (5) follow :

$$\Delta A_{zEWN} = A_{zERN} - A_{zWDN} = 2\gamma_o \sin 30^o + 2\Delta\gamma_o \cos 30^o \qquad (13)$$

$$\Delta A_{zWES} = A_{zWRS} - A_{zWDS} = 2\gamma_o \sin 30^o + 2\Delta\gamma_o \cos 30^o \qquad (14)$$

and from here

$$\Delta A_{zEWN} - \Delta A_{zWES} = \emptyset \qquad (15)$$

In the second group of the measurements the north stars were observed in the order WD-ER, while the south order was ED-WR. That brought to:

$$\Delta A_{zWEN} = A_{zWDN} - A_{zERN} = -2\gamma_o \sin 30^o - 2\Delta\gamma_o \cos 30^o \quad (16)$$

$$\Delta A_{zEWS} = A_{zEDS} - A_{zWRS} = -2\gamma_o \sin 30^o - 2\Delta\gamma_o \cos 30^o \quad (17)$$

and from here:

$$\Delta A_{zWEN} - \Delta A_{zEWS} = \emptyset \quad (18)$$

Accordingly, if we accept the equation (1), it would come to the value (13) - (18).Our autocollimational measurements of the fictive stars at $z = \pm 30^o$, however, cannot confirm the conclusions (15) and (18). We are giving a special emphasis on this fact.

In the first group of measurements the differences of autocollimational measurements were always positive as indicated in equations (13) and (14). But the differences ΔA_{zEWN} and ΔA_{zWES} in our measurements were always diverse to zero. We obtained:

$$\Delta A_{zEWN} - \Delta A_{zWES} = (A_{zERN} - A_{zWDN}) - (A_{zWRS} - A_{zEDS}) = -(A_{zWDN} - A_{zERN}) - (A_{zWRS} - A_{zEDS}) = p$$

respectively

$$(A_{zWDN} - A_{zERN}) + (A_{zWRS} - A_{zEDS}) = -p \quad (19)$$

The second group of measurements gives the expression (19) too.

The table 10 contains the basic data from these measurements. "Vertical temperature gradient" is the mean value of air temperature differences measured by the thermistore pair I. ΔA_s signs the mean value of all ΔA_{zE} and ΔA_{zW} in one series of the measurements, and μ its mean error. r is correlation coefficient between the individual ΔA_z and indications of separate thermistores.

Maximal changes of differences with unprotected tube, indicated by II thermistore is 0°16, and III 0°11 C. When the tube is protected II gives value 0°05, and III 0°02 C, what is conspicuously smaller.

With the unprotected tube ΔA_S is changeable and it veries in wide limits, while, on the contrary, the protected tube brings about from evening to evening conspicuously smaller changes of these values. The values μ indicate to the fact that the protection of tube reduces considerably dispersion of value ΔA_Z in the same series (during a night) of measurements. Their changes are relatively the smallest at the open dome. If the tube has not been protected, the changes of separate values ΔA_Z are correlating well with the corresponding values in the combination of thermistore data (II - III) - the only exception is the measurement done on 19.I 70., when, however, a negative temperature gradient was in the pavilion. The value r, at the protected tube, does not show much of ony striking tendency.

The value p, except only in one case, when was practically zero, is always a positive value. The question is - what is this fact pointing to? It shows that in the equation (1) the value A_O is changable and not constant as it was originally supposed. Or, another possibility, that (1) is not real and does not indicate the real phisical state of our instrument (it might be necessary to form another, new, equation which will correspond to our instrument, or, the equation (1) should undergo certain modification).

If A_O represents a changeable value - if the change of A_O is existing between the measurements effected from evening to evening (as already indicated) but, also, in short periods of time in two tubes positions (probably caused by diverse temperature influences on the tube) - it may be understood that micrometric zero point is changed actually. This statement is very important as that means that at the calculation of latitude or declination out of the stars observation it cannot be supposed that micrometric zero point in two instrument positions remains unchanged. In case the micrometric zero point is changeable, in calculations of zenith distance that brings about the following correction:

with north stars: $$\Delta z_N = \frac{1}{2}(M_{oW} - M_{oE})_N R \quad (20)$$

with south stars: $$\Delta z_s = \frac{1}{2}(M_{oE} - M_{oW})_S R \quad (21)$$

where M_{oE} and M_{oW} are micrometric zero points in E respectively W position of instrument. Out of (20) and (21) we may obtain:

$$\Delta z_N - \Delta z_S = \frac{1}{2}\left[(M_{oW} - M_{oE})_N - (M_{oE} - M_{oW})_S\right] R$$

respectively

$$\Delta z_N - \Delta z_S = \frac{1}{2}\left[(M_{oW} - M_{oE})_N + (M_{oW} - M_{oE})_S\right] R \quad (22)$$

At the supposition of the changeability of the micrometric zero point, the value in bracket in (22) may be equalized with (19), what brings us to:

$$\Delta z_N - \Delta z_S = -\frac{1}{2} p R \quad (23)$$

Since p is practically always a positive number, it means that Δz_N is always smaller than Δz_S. Therefore, if the micrometric zero point is movable, than we could add to the latitude of the south stars more than it may be reduced from the latitude carried out from the north stars. According to that it is pointed to the possibility of existance of the systematical difference between latitudes carried out from the north and south stars observations just in the way shown with the results in [2].

The value p is not constant. This is concluded on the grounds of analysis from the previous autocollimational measurements as well as from some new ones. Autocollimational measurements at various zenith distances have been analysed so that the difference of autocollimational readings was taken in consideration when the tube was in the zenith and also in the determined zenith distance (therefore it concerns the difference $A_{z=o} - A_z$). The absolute values of these differences indicated to the existance of deviation depending on the fact whether the tube was directed towards the south or north and that the same was chiefly of a systematical character. The difference of the absolute values $(A_{z=o} - A_z)$ at the same zenith distances towards north and south (if the sign is + the north values is bigger) will be marked by d_1. At the 15° tube rotation, and E instrument position, at z=15° d_1 is -0,0020R, at z=90° about -0,0500R (=1"). In W position, those values are nearly alike as in E position, but with sign +, speaking about only one systematical influence. - From the measurements through the whole circle, with 30° rotation, is following chiefly systematical influence, as well, but the most striking is the change of value d_1 in the function from the tubes rotation direction - the differences d_1 are biger when the retrograde movement is in action.

Values d_1 are not constant, but very changeable. This has been ascertained by the measurements carried out by M. Mijatov. In E position, the tube has been continously moved accross

T A B L E 10.

date	Air temp. (in °C)	Vert. temp. gradient (in °C/2,5m)	ΔA_s	μ	p	r/II/	r/III/	r/II+III/	r/II-III/	Dome
			$\Delta A_s, \mu$ i p in units of R; r in units of 0,01							
					Unprotected tube					
15.X.1969.	+14.7	+0.9	1.5058	±0.0233	+0.0139	+47	+86	+75	-62	open
16.X.1969.	+13.4	+0.1	1.4074	819	+ 248	-84	+68	-28	-80	
19.I.1970.	+ 0.2	-0.1	1.4608	256	+ 40	+10	+34	+17	+01	
24.I.1970.	- 0.6	+0.3	1.4693	554	+ 152	-92	+49	-80	-90	
27.I.1970.	+ 2.6	>+2.0	1.4807	169	- 5	-59	+26	00	-82	
18.III.1970.	+ 5.8	>+2.0	1.4975	345	+ 21	-12	+52	+23	-48	
20.III.1970.	+ 5.3	+1.5	1.4903	±0.0492	+0.0217	-81	+90	+46	-89	
					Protected tube					
21.X.1969.	+13.6	+1.3	1.4879	±0.0281	+0.0020	+11	00	+07	+14	open
22.X.1969.	+10.8	-0.4	1.4792	399	+ 55	-35	-31	-43	-17	
5.XI.1969.	+12.4	+1.5	1.4944	207	+ 47	+16	+11	+23	+08	
18.III.1970.	+ 5.9	>+2.0	1.4802	±0.0150	+0.0002	+17	-53	-23	+40	

the arc from 120^o, from and to 60^o of the zenith distances in both directions. The main purpose has been to examine the behaviour of the autocollimational measurements in the zenith zone, where the tube was been rotated by 2^o. Table 11 is indicating the obtained values of d_1, their mean value (d_{1s}) and the mean absolute value ($|d_1|_s$), as well as the correlation coefficients r among the values d_1 and corresponding thermistore indications. The difference among the measurements done on 9. IV and 10. IV was only because on the other day the observations were done without the tube dew cap. The dome was closed, the tube was without protection.

TABLE 11.

in units of R

zenithal distance	9. April 1970.		10. April 1970.	
	Direction		Direction	
	Direct	retrograde	direct	retrograde
60^o	-0.0503	+0.0025	+0.0186	-0.0192
50	- 375	+ 192	- 174	- 210
40	- 236	+ 168	- 509	- 65
30	- 174	+ 508	- 412	+ 80
20	- 22	+ 613	- 110	+ 288
10	- 90	+ 360	- 212	+ 307
8	+ 47	+ 555	+ 96	+ 145
6	+ 272	+ 312	- 104	+ 42
4	+ 435	+ 437	- 127	+ 132
2	+0.0332	+0.0275	-0.0232	-0.0097
d_{1s}	-0.0031	+0.0344	-0.0160	-0.0043
$\|d_1\|_s$	0.0249	0.0344	0.0216	0.0156
r(II)	+ 0.97	+ 0.52	+ 0.35	+ 0.49
r(III)	- 0.95	- 0.27	- 0.17	- 0.53
r(II + III)	+ 0.97	+ 0.57	+ 0.58	+ 0.33
r(II - III)	+ 0.97	+ 0.47	+ 0.27	+ 0.51

The results are showing variability of the data d_1. It is seen that the maximal influence is not in great extend dependent on the tube zenith distance. A relatively good correlation with temperature changes is apparent, being registered on thermistores.

Observational conditions at autocollimational measurements and the observations of stars are different and therefore it would be impossible to give a comparison of numerical data. Our purpose was only to point out that the autocollimational measurements were confirming the existance of difference at the same zenith distances depending on the fact whether the tube was directed towards the north or south what may bring about changes in the latitude values just in the way we have already established.

6. Other examinations. - A connection among the variations of the autocollimation readings and the changes of thermistore indications near the objective (III thermistore pair), has been searched. The tube was in the horizontal position, and autocollimation and thermistores were read every 2^m On 24th September 1969. two series of measurements were carried out. In the first, that lasted 26^m, the change of autocollimation was followed, accordingly it was obtained that the correlation coefficient was r=+0,55. The second series lasted 46^m, but in the middle of that interval the dome was closed. That closing brought about considerable changes of values, while for the correlation coeficient, for the whole series, the value of +0,90 was obtained. According to that there was

a high correlation with indication of III thermistore pair and in the same way as percieved with the unprotected tube in table 6 and 10. A_s natural it appeared that a special care should be paid to the question of the objective position.

With the unprotected tube and closed dome, a number of times the tube was directed to z = + 45° (south) starting always with the tube from the zenith or from the horizon, either with careful or listless conduction. The following results were obtained:

	a) from the zenith to z = + 45°	b) from the horizon to z = + 45°	Difference a - b
by careful tube conduction	23,3698	23,3635	+ 0,0063
by listless tube conduction	23,3753	23,3657	+ 0,0096

The above clearly indicates the existence of difference depending on the direction of the tube conduction, as well as how carefully we are conducting the tube to the determined position. In any way is evident that the careful conduction is causing a smaller number of the systematical deviations.

7. Conclusion. - These examinations are indicating that the characteristics of the optical and mechanical tube unity of this instrument are changeable, in the function of the temperature factors mostly, and that these changes are causing considerate influences on the observational values. The tube protection does not eliminated these disturbances but it reduces their influence of accidental character what is, after all, very important, and it confirms the necessity for the tube protection. The autocollimational measurements are justifying the possibility of the existance of the systematical differences in the latitudes obtained from the south and north stars observations.

The newest observations of stars when the tube protection was effected by the aluminium folios, showed that the difference between the north and south stars latitudes was still existing. The change in accordance with the prevous condition is the fact that with the protected tube the dispersion of data is lessened. Therefore, that tendency is the same as the one with the autocollimational measurements.

The above explanation points out the fact that certain corrections have to be done on the Belgrade vertical circles what does not mean only the stabilisation of axes, as mentioned in [2], but also it requires rectification of the tubes imperfectness as regards the optical and mechanical systems which are causing considerate disturbances.

The fixing of the parts and mechanical quality of the tube should be also examined. Only after elimination of these drawbacks, the tube and its parts should get a good protection against the outer temperature disturbing factors (experiences given in [6] are chiefly used for this isolation).

After these important technical check--ups have been completed and the corrections done, new observations of stars should be carried out (with new autocollimational measurements also) and only then we would be able to judge whether the Belgrade large vertical circle is capable for qualitative observations of stars by the absolute method, or even with a relative method. If it is the case, then it would be obligatory to adhere to the modernisation of the observations of stars and circle readings - being certainly the second part of the previously mentioned request.

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Summary:

By the autocollimational method, the stability of the tube's optical and mechanical unity of the Belgrade large vertical circle has been examined under various conditions. These examinations indicated that the general charactheristics of the tube are changeable, in the function of the temperature factors chiefly, and that the same may have a great influence on the observational values. The real existance of differences in the observational data of north and south stars has been established, being pointed out already in [2] .

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OBSERVATIONS DES PETITES PLANETES A L'OBSERVATOIRE ASTRONOMIQUE DE BELGRADE EN 1967, 1968 ET 1969

par D. Olević

On donne ici les positions précises des petites planètes plus brillants au cours de 1967(28), 1968 (52) et 1969 (55) observées au Zeiss astrog-raphe 160/800 mm de Belgrade.

Nous avons utilisé les Astro Platten Agfa et ORWO en 1967 - 1968 et les plaques Gevaert en 1969. Le temps d'utilisation des plaques était surpassé pour quelques plaques, ce qui produit la difficulté au cours de mesures. Nous avons faits les mesures à la machine d'Askania dans les deux positions de la plaque qui diférrent de 180°.

Deux tableaux contiennent:

I : Numero d'ordre, l'époque d'observation, l'assension droit, la declinaison, log du facteur parallactique en α et δ et O-C ;

II : Numero d'ordre, nombre du cliché, l'étoiles de repères (catalogue BD ou l'autre), les dépendences.

T A B L E A U II

N°	No. Cl.	BD	Yal. vol.	Dépendences
1.	100/67	+17°1882	18	0.392 851
		+16 1770	"	.414.611
		+16 1779	"	.192 538
2.	102/67	+17°1882	18	0.392 836
		+16 1770	"	.414 885
		+16 1779	"	.192 279
3.	107/67	+17°1882	18	0.209 694
		+16 1770	"	.520 657
		+17 1896	"	.269 648
4.	10/67	- 2°5883	17	0.357 801
		- 4 5833	"	.326 009
		- 3 5592	"	.316 190
5.	14/67	- 4°5815	17	0.368 252
		- 3 5577	"	.388 112
		- 4 5837	"	.243 635
6.	21/67	- 5°5870	17	0.411 273
		- 5 5885	"	.316 994
		- 4 5793	"	.271 734
7.	23/67	- 6°6075	17	0.262 716
		- 4 5775	"	.384 824
		- 5 5885	"	.352 459
8.	31/67	- 4°5759	17	0.499 944
		- 6 6075	"	.344 906
		- 5 5880	"	.155 150
9.	38/67	- 4°5716	17	0.261 087
		- 7 5839	16	.366 185
		- 5 5866	17	.372 719
10.	50/67	- 5°5820	17	0.318 213
		- 6 6052	16	.413 693
		- 5 5855	17	.268 094
11.	54/67	- 5°5820	17	0.290 793
		- 6 6052	16	.408 338
		- 5 5855	17	.300 870
12.	78/67	+22°1764	25	0.354 919
		+20 1913	"	.364 872
		+21 1707	"	.280 209
13.	98/67	+22°1780	25	0.223 488
		+21 1693	"	.435 889
		+21 1707	"	.340 623
14.	105/67	+21°1689	25	0.430 434
		+22 1780	"	.320 006
		+21 1707	"	.249 560
15.	40/67	- 3°5631	17	0.306 609
		- 2 5973	"	.447 288
		- 3 5661	"	.246 102

N°	No. Cl.	BD	Yal.vol.	Dépendences
16.	34/67	+ 4° 327	22	0.258 834
		+ 4 340	20	.324 979
		+ 3 273	"	.416 181
17.	29/67	+24° 503	25	0.412 173
		+23 473	"	.269 314
		+25 580	24	.318 512
18.	37/67	+24° 506	25	0.399 304
		+24 512	"	.255 702
		+25 565	24	.344 987
19.	45/67	+24° 490	25	0.357 186
		+23 462	"	.339 619
		+24 506	"	.303 194
20.	65/67	+21° 422	25	0.404 923
		+22 466	"	.348 590
		+20 539	"	.246 486
21.	66/67	+21° 422	25	0.412 275
		+22 466	"	.342 284
		+20 539	"	.245 441
22.	84/67	+18° 376	18	0.252 409
		+18 383	"	.424 157
		+18 391	"	.323 434
23.	86/67	+18° 376	18	0.269 177
		+18 383	"	.404 175
		+18 391	"	.326 648
24.	91/67	+17° 457	18	0.280 086
		+18 376	"	.318 304
		+18 383	"	.401 610
25.	94/67	+18° 370	18	0.212 627
		+17 457	"	.308 627
		+18 376	"	.478 746
26.	93/67	+29° 742	24	0.260 882
		+30 732	"	.389 886
		+29 750	"	.349 232
27.	96/67	+30° 713	24	0.405 746
		+30 732	"	.238 939
		+29 750	"	.355 315
28.	16/67	- 1°4336	21	0.358 882
		- 1 4341	"	.337 686
		- 2 5826	17	.303 432

T A B L E A U I

N°	Planète		1967 TU		α (1950)	δ (1950)	$(p_\alpha \Delta)$	$(p_\delta \Delta)$	(O-C)	
1.	11	Parthenope	nov.	28.12609	$8^h33^m53^s.491$	+16°51'42."56	8.489	0.612	$0^m.0$	0'
2.			nov.	28.15803	8 33 53.463	+16 51 42.56	9.098	0.619	0.0	0
3.			dec.	1.11742	8 34 5.699	+16 53 46.63	8.461	0.611	0.0	0
4.	30	Urania	sep.	3.97337	23 7 9.642	- 3 8 36.63	8.676	0.812	-2.8	-16
5.			sep.	5.97545	23 5 19.319	- 3 17 29.22	8.847	0.813	-2.8	-15
6.			sep.	21.95426	22 50 56.260	- 4 31 5.05	9.183	0.819	-2.8	-16
7.			sep.	23.92185	22 49 22.111	- 4 39 31.69	8.942	0.822	-2.7	-15
8.			sep.	27.90494	22 46 24.482	- 4 55 34.81	8.864	0.825	-2.6	-15
9.			okt.	6.83791	22 41 13.302	- 5 24 56.14	8.490n	0.828	-2.5	-14
10.			okt.	23.81115	22 38 9.000	- 5 46 5.09	8.517	0.830	-2.2	-13
11.			okt.	25.80281	22 38 24.287	- 5 45 17.92	8.395	0.830	-2.2	-13
12.	40	Harmonia	nov.	16.10209	7 45 47.156	+21 0 27.43	8.565n	0.547	0.0	0
13.			nov.	28.08755	7 47 2.006	+21 19 34.48	8.132	0.541	0.0	0
14.			dec.	1.07539	7 46 19.691	+21 29 56.27	7.370	0.538	0.0	0
15.	48	Doris	okt.	6.89624	23 26 34.256	- 2 35 0.83	8.664	0.809	-0.1	- 1
16.	201	Penelope	sep.	30.01709	1 56 16.882	+ 4 50 15.54	8.618	0.749	+0.5	+ 1
17.	230	Athamantis	sep.	26.06154	3 31 0.983	+25 6 43.15	8.677n	0.469	+1.9	+ 2
18.			sep.	30.12230	3 31 15.536	+24 59 35.12	9.195	0.492	+1.8	+ 2
19.			okt.	14.04311	3 27 48.665	+24 11 10.88	8.677	0.488	+2.0	+ 2
20.			nov.	2.95097	3 13 5.651	+21 57 15.41	8.487n	0.530	+2.2	+ 3
21.			nov.	2.98647	3 13 3.619	+21 56 55.94	8.843	0.533	+2.2	+ 3
22.			nov.	20.86251	2 56 1.739	+19 12 53.49	9.023n	0.583	+2.1	+ 3
23.			nov.	20.90765	2 55 59.080	+19 12 25.94	8.279	0.576	+2.1	+ 3
24.			nov.	22.92136	2 54 13.601	+18 53 33.50	8.876	0.583	+2.1	+ 3
25.			nov.	24.90290	2 52 33.742	+18 35 14.68	8.628	0.586	+2.2	+ 3
26.	349	Dembowska	nov.	22.97883	4 48 39.049	+30 6 33.06	8.219	0.344	+0.2	0
27.			nov.	24.95759	4 46 42.342	+30 9 31.94	8.434n	0.342	+0.2	0
28.	419	Aurelia	sep.	7.94732	22 40 53.805	- 1 14 16.31	8.743	0.800	-0.2	- 8

T A B L E A U I

N°		Planète	1968 TU		α (1950)	δ (1950)	(pΔα)	(pΔδ)	(0–C)	
1.	1	Ceres	mart	24.04367	$14^h26^m43^s.732$	- 0° 6' 48".42	7.905	0.790	$-0^s.21$	+0".3
2.			mart	27.01418	14 25 8.981	+ 0 4 16.03	8.652n	0.789	-0.12	-0.5
3.			apr.	1.00447	14 22 2.851	+ 0 22 46.99	8.045n	0.787	-0.03	-2.9
4.			apr.	18.96141	14 7 34.392	+ 1 18 41.48	8.123	0.780	-0.21	+1.8
5.			apr.	23.93954	14 3 7.618	+ 1 28 19.69	6.386n	0.779	-0.19	+0.1
6.	2	Pallas	feb.	20.01352	11 47 56.328	- 6 6 20.46	8.290n	0.738	-0.66	-3.5
7.			mart	23.94682	11 27 10.033	+ 7 5 40.65	8.905	0.729	-0.57	-2.4
8.			mart	26.94560	11 25 21.145	+ 3 14 1.01	9.008	0.719	-0.67	-3.2
9.			apr.	18.88991	11 17 29.462	+15 2 23.67	9.137	0.645	-0.73	-3.3
10.	3	Juno	mart	24.08361	14 50 32.559	- 4 21 43.19	8.853	0.792	-0.20	-0.2
11.			mart	27.07789	14 49 14.750	- 4 1 19.62	8.922	0.818	+0.01	+1.3
12.			mart	30.03709	14 47 47.481	- 3 40 47.29	7.653n	0.817	-0.01	-0.5
13.			apr.	18.99685	14 34 29.496	- 1 20 22.28	8.757	0.800	-0.20	+0.7
14.			apr.	23.95898	14 30 34.988	- 0 47 52.77	6.987	0.796	-0.16	-1.4
15.			maj	3.92261	14 22 37.126	+ 0 10 13.93	7.922n	0.789	-0.15	-1.2
16.	4	Vesta	dec.	7.79658	1 26 21.911	- 0 30 29.55	8.220	0.794	+0.09	+0.7
17.			dec.	10.80353	1 26 16.674	- 0 17 14.10	8.752	0.793	$+0^s.03$	+0".3
18.	6	Hebe	jun	9.01667	18 48 41.230	- 5 22 56.73	8.115	0.828	$0^m.0$	0'
19.			jun	26.93365	18 33 10.454	- 6 14 28.73	8.677n	0.833	0.0	0
20.	10	Hygie	avg.	6.04850	0 29 4.184	+ 8 8 0.73	9.027n	0.719	+0.1	-2
21.	11	Parthenope	feb.	5.90279	7 46 52.548	+20 49 35.56	8.542	0.549	0.0	0
22.			feb.	19.87778	7 36 55.213	+21 36 8.61	8.938	0.541	0.0	0
23.	13	Egeria	mart	23.98657	13 35 24.106	+ 5 43 22.24	8.687n	0.742	0.0	0
24.			mart	26.97234	13 32 32.986	+ 4 46 26.00	8.773n	0.742	0.0	0
25.			mart	29.97321	13 29 32.638	+ 4 48 49.15	8.478n	0.750	0.0	0
26.			mart	31.98294	13 27 27.983	+ 4 49 55.51	8.139	0.750	0.0	0
27.			apr.	18.93363	13 8 16.278	+ 4 36 59.60	8.684	0.752	0.0	0
28.			maj	3.86665	12 54 45.379	+ 3 48 25.58	7.653	0.759	0.0	0
29.	15	Eunomia	nov.	1.02244	4 19 29.540	+38 35 44.69	8.578	9.968	0.0	0
30.	16	Psyche	maj	3.94866	14 58 41.450	-12 25 28.83	7.756	0.868	+0.2	+2
31.	21	Lutetia	feb.	19.97013	10 2 59.666	+16 36 2.26	8.780	0.616	-0.3	0
32.			feb.	22.97880	$10^h 0^m 15.455$	+16°52' 7".86	9.044	0.614	-0.3	0'
33.	22	Kaliopa	mart	23.92064	11 0 42.595	+27 37 41.85	8.827	0.414	0.0	0
34.			mart	26.91140	10 58 31.686	+27 36 19.31	8.835	0.415	0.0	0
35.			apr.	24.83919	10 47 14.856	+25 49 11.29	9.040	0.462	0.0	0
36.	39	Laeticia	jun	9.05538	19 23 0.080	- 8 40 56.06	8.721	0.847	-1.4	+4
37.	40	Harmonia	feb.	5.85928	6 48 17.921	+25 28 45.34	8.358	0.459	0.0	0

T A B L E A U I

N°	Planète		1968 TU		α (1950)	δ (1950)	(p Δα)	(p Δδ)	(O-C) m	
38.	43	Ariadna	mart	31.90377	11 6 31.113	- 0 51 26.70	8.792	0.796	-0.3	+1
39.	44	Nysa	dec.	10.84346	2 32 51.176	+ 8 50 34.26	8.610	0.710	-0.2	+1
40.			dec.	17.81083	2 30 46.935	+ 8 59 0.65	7.940	0.709	-0.2	+1
41.	52	Europa	apr.	25.02669	16 6 43.751	-10 38 33.21	8.051	0.859	+0.2	0
42.			maj	4.01393	16 0 55.110	- 9 13 2.03	8.726	0.850	+0.2	0
43.	80	Sapho	apr.	24.92245	13 7 3.718	-10 35.25.09	8.812	0.857	0.0	0
44.	85	Io	maj	3.99970	16 35 42.120	-10 40 57.38	8.691n	0.877	+0.3	0
45.			maj	27.95609	16 17 28.295	- 7 40 26.43	8.635	0.842	+0.3	0
46.	89	Julia	avg.	5.97425	22 2 46.691	- 5 36 8.71	8.554n	0.828	+0.5	+4
47.	129	Antigona	okt.	31.99815	4 2 32.634	+ 3 43 54.79	7.464n	0.760	0.0	0
48.	192	Nansikaa	feb.	19.89964	8 18 59.855	+25 15 16.73	8.835	0.468	-0.9	+3
49.	194	Prokne	apr.	24.87912	12 34 7.610	+13 11 4.71	8.020	0.661	-2.3	+2
50.	354	Eleonora	feb.	22.93435	9 14 33.955	+17 16 37.46	8.887	0.608	0.0	+1
51.	511	Davida	nov.	1.11934	7 3 31.170	+14 50 20.32	8.171n	0.640	0.0	0
52.			dec.	16.97368	6 53 18.416	+17 40 15.17	8.705n	0.601	0.0	0

T A B L E A U II

N°	No Cl.	BD	Yal. vol.	Dépendences
1.	25/68	+ 0°3185	21	0.179 366
		+ 0 3186	"	.415 529
		+ 0 3196	"	.405 104
2.	34/68	+ 1°2924	21	0.340 176
		- 0 2821	"	.277 214
		+ 0 3196	"	.382 610
3.	50/68	+ 0°3165	21	0.317 294
		+ 0 3171	"	.320 469
		+ 1 2941	20	.362 237
4.	56/68	+ 1°2889	20	0.251 562
		+ 1 2895	"	.325 962
		+ 2 2783	"	.422 475
5.	63/68	+ 1°2872	20	0.264 280
		+ 1 2889	"	.440 162
		+ 2 2773	"	.295 558
6.	11/68	- 4°3148	17	0.257 192
		- 6 3456	"	.399 516
		- 5 3377	"	.343 292
7.	21/68	+ 7°2443	22/1	0.351 217
		+ 8 2512	"	.253 027
		+ 7 2461	"	.395 756
8.	31/68	+ 8°2504	22	0.219 786
		+ 9 2497	"	.580 059
		+ 8 2515	"	.200 154
9.	53/68	+14°2368	19	0.228 820
		+16 2242	18	.298 426
		+15 2326	19	.472 754
10.	27/68	- 3°3675	17	0.248 998
		- 3 3686	"	.401 757
		- 4 3772	"	.349 245
11.	37/68	- 3°3679	17	0.438 170
		- 4 3763	"	.315 932
		- 3 3686	"	.245 898
12.	45/68	- 3°3674	17	0.288 549
		- 3 3680	"	.383 177
		- 2 3907	"	.328 274
13.	58/68	- 1°2963	21	0.269 456
		- 0 2847	"	.371 981
		- 1 2973	"	.358 563
14.	64/68	- 0°2833	21	0.441 712
		+ 0 3203	"	.317 008
		- 0 2847	"	.241 279
15.	78/68	+ 0°3178	21	0.428 864
		+ 0 3180	"	.408 158
		+ 0 3185	"	.162 978

T A B L E A U II

N^{o}	No Cl.	BD	Yal.vol.	Dépendences
16.	125/68	- 1^{o} 188	21	0.265 822
		- 1 196	"	.499 044
		- 0 240	"	.235 134
17.	127/68	- 0^{o} 229	21	0.357 217
		- 1 196	"	.263 048
		- 0 240	"	.379 736
18.	89/68	- 5^{o}4768	17	0.226 964
		- 5 4787	"	.418 810
		- 6 4941	"	.354 226
19.	97/68	- 6^{o}4791	17	0.300 360
		- 6 4809	16	.485 441
		- 6 4812	"	.214 198
20.	102/68	+ 7^{o} 59	22	0.350 127
		+ 8 62	"	.271 457
		+ 7 75	"	.378 416
21.	3/68	+21^{o}1677	25	0.392 942
		+20 1922	"	.428 576
		+21 1724	"	.178 482
22.	7/68	+22 1744	25	0.585 314
		+21 1658	"	.171 085
		+21 1661	"	.243 601
23.	22/68	+ 5^{o}2769	22	0.226 444
		+ 4 2768	"	.456 226
		+ 5 2783	"	.317 330
24.	32/68	+ 4^{o}2755	22	0.261 563
		+ 5 2769	"	.312 187
		+ 5 2774	"	.426 250
25.	42/68	+ 5^{o}2749	22	0.226 165
		+ 5 2757	"	.412 617
		+ 5 2769	"	.361 218
26.	49/68	+ 5^{o}2749	22	0.486 536
		+ 6 2751	"	.183 949
		+ 5 2757	"	.329 515
27.	55/68	+ 4^{o}2697	22	0.271 277
		+ 5 2720	"	.291 927
		+ 4 2703	"	.436 796
28.	75/68	+ 4^{o}2666	20	0.404 061
		+ 3 2714	"	.210 461
		+ 4 2684	"	.385 478
29.	111/68	+38^{o} 876	AGK2	0.355 445
		+38 877	"	.271 114
		+38 888	"	.373 440
30.	79/68	-12^{o}4178	11	0.261 606
		-11 3858	"	.395 072
		-12 4192	"	.343 321
31.	B/68	+18^{o}2313	18	0.281 138
		+16 2077	"	.546 095
		+16 2080	"	.172 766
32.	17/68	+18^{o}2302	18	0.175 969
		+17 2164	"	.477 211
		+17 2169	"	.346 820
33.	19/68	+28^{o}1959	24	0.325 290
		+28 1961	"	.288 103
		+27 1978	"	.386 608
34.	29/68	+27^{o}1951	24	0.270 316
		+28 1961	"	.470 131
		+27 1978	"	.259 553
35.	66/68	+26^{o}2133	24	0.134 658
		+26 2136	"	.635 374
		+26 2137	"	.229 968
36.	91/68	- 8^{o}4960	16	0.199 702
		- 9 5130	"	.480 694
		- 8 4977	"	.319 603
37.	1/68	+25^{o}1446	24	0.353 964
		+25 1469	"	.385 198
		+25 1478	"	.260 837
38.	46/68	- 0^{o}2407	21	0.428 006
		- 0 2409	"	.474 362
		- 0 2414	"	.097 631
39.	128/68	+ 8^{o} 385	22	0.175 878
		+ 8 396	"	.380 225
		+ 8 407	"	.443 896
40.	129/68	+ 8^{o} 385	22	0.336 788
		+ 8 396	"	.453 010
		+ 8 407	"	.210 202
41.	73/68	-10^{o}4252	11	0.380 128
		-10 4258	"	.416 869
		-10 4265	"	.203 002
42.	82/68	- 9^{o}4278	16	0.290 796
		- 9 4291	"	.229 142
		-10 4242	11	.480 062
43.	69/68	- 9^{o}3628	16	0.437 761
		- 9 3636	"	.173 598
		-10 3627	11	.388 641
44.	83/68	-10^{o}4339	11	0.355 320
		-10 4358	"	.296 249
		-10 4373	"	.348 431
45.	88/68	- 7 4275	16	0.333 077
		- 6 4399	"	.294 868
		- 7 4275	"	.372 054
46.	100/68	- 6 5901	16	0.335 069
		- 5 5697	17	.310 769
		- 6 5914	16	.354 161

N°	No Cl.	BD	Yal.vol.	Dépendences
47.	110/68	+ 3° 552	20	0.303 839
		+ 3 557	"	.489 534
		+ 3 563	"	.207 127
48.	8/68	+25°1898	24	0.362 476
		+26 1770	"	.237 380
		+25 1912	"	.400 144
49.	67/68	+13°2551	19	0.340 944
		+13 2561	"	.471 522
		+13 2562	"	.187 534
50.	15/68	+18°2150	18	0.290 538
		+17 2053	"	.461 014
		+17 2057	"	.248 448
51.	114/68	+14°1558	19	0.228 477
		+14 1568	"	.307 967
		+15 1461	"	.463 556
52.	131/68	+17°1435	18	0.285 973
		+17 1447	"	.583 473
		+17 1469	"	.130 554

T A B L E A U II

N°	No Cl.	BD	Yal.vol.	Dépendences
1.	19/69	+16°3563	18	0.388 740
		+15 3525	"	.423 024
		+15 3543	"	.188 236
2.	30/69	+21°3498	25	0.345 565
		+21 3515	"	.357 311
		+21 3518	"	.297 124
3.	36/69	+22°3402	25	0.282 658
		+22 3418	"	.633 516
		+22 3435	"	.183 826
4.	41/69	+24°3377	25	0.309 628
		+23 3327	"	.449 633
		+24 3421	"	.240 739
5.	44/69	+24°3369	25	0.302 963
		+23 3287	"	.343 354
		+24 3377	"	.353 683
6.	42/69	- 4°4583	17	0.227 001
		- 5 4786	"	.415 909
		- 4 4608	"	.357 090
7.	45/69	- 4°4561	17	0.299 730
		- 4 4565	"	.307 737
		- 5 4768	"	.392 533
8.	47/69	- 4°4537	17	0.460 287
		- 4 4547	"	.098 759
		- 4 4561	"	.440 953
9.	78/69	+12° 555	19	0.182 365
		+13 651	"	.361 005
		+12 564	"	.456 630
10.	79/69	+12° 555	19	0.183 451
		+13 651	"	.359 649
		+12 564	"	.456 899
11.	80/69	+ 9°1623	22/2	0.421 241
		+ 8 1750	"	.168 067
		+ 9 1639	"	.410 692
12.	91/69	+ 9°1639	22/2	0.145 972
		+ 8 1780	22/1	.660 505
		+ 8 1781	"	.193 523
13.	92/69	+ 9°1639	22/2	0.137 374
		+ 8 1780	22/1	.669 454
		+ 8 1781	"	.193 172
14.	58/69	+17° 123	18	0.329 311
		+16 96	"	.228 970
		+16 97	"	.441 719
15.	59/69	+17° 123	18	0.331 080
		+16 96	"	.231 374
		+16 97	"	.384 763
16.	63/69	+17° 123	18	0.384 763
		+16 96	"	.303 740
		+16 97	"	.311 496
17.	68/69	+16° 62	18	0.353 962
		+16 74	"	.304 478
		+15 122	"	.341 559
18.	81/69	+14° 76	19	0.342 216
		+15 95	18	.374 596
		+14 111	19	.283 188
19.	3/69	+25°2109	24	0.296 141
		+24 2099	25	.321 787
		+24 2102	24	.382 072
20.	7/69	+25°2105	24	0.414 305
		+24 2099	25	.410 435
		+24 2102	24	.175 259
21.	12/69	+25°2089	25	0.096 498
		+25 2105	24	.438 419
		+24 2099	25	.465 082
22.	20/69	- 8°3905	16	0.365 289
		- 9 4075	"	.129 729
		- 9 4083	"	.504 982
23.	22/69	- 9°4062	16	0.202 633
		- 8 3905	"	.530 545
		- 8 3908	"	.266 821
24.	26/69	- 8°3884	16	0.373 150
		- 8 3905	"	.463 989
		- 8 3908	"	.162 851

N°	No Cl.	BD	Yal.vol.	Dépendances
25.	27/69	- 7 3900	16	0.299 624
		- 7 3906	"	.278 945
		- 7 3912	"	.421 432
26.	32/69	- 7°3900	16	0.412 814
		- 7 3903	"	.210 937
		- 4 3906	"	.376 249
27.	35/69	- 7°3881	16	0.148 523
		- 7 3884	"	.607 297
		- 7 4050	"	.244 180
28.	48/69	-15°5881	12	0.207 142
		-14 5936	"	.432 202
		-14 5949	"	.360 655
29.	49/69	-15°5881	12	0.229 887
		-14 5936	"	.415 748
		-14 5949	"	.354 365
30.	71/69	+ 6° 626	22	0.297 626
		+ 7 595	"	.292 783
		+ 6 636	"	.409 590
31.	72/69	+ 6° 626	22	0.299 725
		+ 7 595	"	.289 837
		+ 6 636	"	.410 438
32.	83/69	+ 6° 619	22	0.397 852
		+ 5 590	"	.271 821
		+ 6 636	"	.330 327
33.	84/69	+ 6° 619	22	0.398 477
		+ 5 590	"	.275 258
		+ 6 636	"	.326 265
34.	60/69	+17° 315	18	0.280 837
		+18 277	"	.361 020
		+17 327	"	.358 143
35.	64/69	+17° 315	18	0.323 129
		+18 277	"	.362 653
		+17 327	"	.314 218
36.	69/69	+17° 274	18	0.286 124
		+16 217	"	.493 749
		+17 288	"	.220 127
37.	70/69	+17° 274	18	0.291 004
		+16 217	"	.497 613
		+17 288	"	.211 383
38.	76/69	+17° 274	18	0.293 191
		+16 210	"	.431 909
		+16 217	"	.274 900
39.	77/69	+17° 274	18	0.290 405
		+16 210	"	.446 326
		+16 217	"	.263 269
40.	82/69	+16° 205	18	0.248 532
		+17 274	"	.353 797
		+15 273	"	.397 671

N°	No Cl.	BD	Yal.vol.	Dépendences
41.	87/69	+16° 196	18	0.362 876
		+15 268	"	.377 634
		+16 210	"	.259 492
42.	82/69	+ 9° 550	22/2	0.203 644
		+ 9 556	"	.573 725
		+ 9 567	"	.222 631
43.	90/69	+ 9° 550	22/2	0.187 250
		+ 9 556	"	.604 382
		+ 9 567	"	.208 368
44.	57/69	+ 7°5055	22	0.084 030
		+ 8 5079	"	.377 705
		+ 8 5095	"	.538 220
45.	62/69	+ 8°5079	22	0.334 048
		+ 8 5090	"	.407 040
		+ 7 5066	"	.258 911
46.	55/69	- 2°5785	17	0.488 618
		- 1 4336	21	.210 658
		- 3 5490	"	.300 724
47.	56/69	- 2°5785	17	0.492 316
		- 1 4336	21	.210 500
		- 3 5490	"	.297 184
48.	61/69	- 2°5793	17	-
		- 2 5794	"	-
49.	66/69	- 0°4338	21	0.341 278
		- 0 4342	"	.319 478
		- 0 4354	"	.339 244
50.	67/69	- 0°4338	21	0.347 738
		- 0 4342	"	.315 270
		- 0 4354	"	.336 992
51.	5/69	+17°2291	18	0.478 816
		+17 2294	"	.231 650
		+18 2423	"	.289 534
52.	14/69	+18°2408	18	0.382 911
		+17 2291	"	.410 437
		+18 2423	"	.206 652
53.	29/69	+ 1°3450	20	0.208 754
		+ 2 3343	"	.468 887
		+ 2 3373	"	.322 358
54.	40/69	+ 1°3397	20	0.265 414
		+ 2 3265	"	.371 998
		+ 2 3283	"	.362 587
55.	34/69	- 7°4468	16	0.713 515
		- 8 4469	"	.165 853
		- 8 4484	"	.120 632

T A B L E A U I

N°	Planete		1969	TU	α (1950)	δ (1950)	(p Δα)	(p Δδ)	(O-C)	
1.	2	Pallas	apr.	10.12709	$18^h36^m44^s.691$	+15°36'33".29	9.035n	0.634	$-0^s.27$	-0".4
2.			maj	15.05930	18 37 18.871	+21 36 25.44	8.582n	0.536	-0.22	+1.0
3.			maj	23.95926	18 33 16.369	+22 45 54.94	9.368n	0.558	-0.30	+1.6
4.			jun	10.99111	18 20 57.861	+24 12 9.42	8.260	0.486	-0.26	+0.5
5.			jun	18.95592	18 14 23.895	+24 21 52.70	6.601	0.483	-0.25	-1.8
6.	3	Juno	jun	11.02347	18 48 50.371	- 4 54 19.51	8.635	0.824	+0.08	+0.3
7.			jun	19.00356	18 42 42.137	- 4 48 42.78	8.774	0.824	+0.08	+0.3
8.			jun	23.95774	18 38 32.768	- 4 49 35.15	8.247n	0.825	+0.12	+1.9
9.	5	Astrea	okt.	7.07187	4 9 5.450	+13 13 31.75	7.476n	0.660	$0^m.0$	0'
10.			okt.	7.15007	4 9 5.677	+13 13 25.35	9.302	0.676	0.0	0
11.	6	Hebe	okt.	7.14965	7 20 30.964	+ 8 48 52.44	9.162n	0.725	0.0	0
12.			okt.	11.10660	7 25 26.828	+ 8 31 57.16	9.361n	0.726	0.0	0
13.			okt.	11.13128	7 25 28.579	+ 8 31 50.69	9.235n	0.720	0.0	0
14.	7	Iris	sep.	8.99792	0 56 11.262	+17 7 32.12	8.614n	0.608	0.0	0
15.			sep.	9.02500	0 56 10.681	+17 7 34.01	8.864	0.608	0.0	0
16.			sep.	9.98611	0 55 53.048	+17 8 32.18	8.864	0.609	0.0	0
17.			sep.	30.87784	0 43 34.376	+16 21 13.73	9.263n	0.635	0.0	0
18.			okt.	8.92778	0 37 8.173	+15 30 33.43	8.290	0.631	0.0	0
19.	9	Metis	mart	9.84306	9 29 17.745	+24 27 16.35	8.941n	0.487	0.0	0
20.			mart	10.82676	9 28 42.001	+24 27 38.93	9.094n	0.494	0.0	0
21.			mart	12.80593	9 27 35.353	+24 27 47.16	9.310n	0.517	0.0	0
22.	11	Parthenope	apr.	22.00764	15 6 32.342	- 9 32 37.73	8.468	0.852	0.0	0
23.			apr.	26.01632	15 3 10.780	- 9 14 32.91	9.022	0.848	0.0	0
24.			apr.	28.00590	15 1 26.284	- 8 5 41.98	8.978	0.843	0.0	0
25.			maj	14.94339	14 45 42.819	- 7 58 58.13	8.912	0.843	0.0	0
26.			maj	16.93949	14 43 54.962	- 7 52 51.20	8.949	0.841	0.0	0
27.			maj	23.90639	14 38 2.408	- 7 44 44.34	8.799	0.841	0.0	0
28.	16	Psyche	jun	23.99687	21 4 56.300	-14 23 24.37	9.258n	0.868	$+0^m.3$	+1'
29.			jun	24.04846	21 4 55.444	-14 23 27.39	8.735n	0.876	+0.3	+1
30.	39	Laeticia	okt.	5.05276	4 3 45.202	+ 6 51 20.00	8.761n	0.731	0.0	0
31.			okt.	5.08510	4 3 45.137	+ 6 51 8.45	8.442	0.731	0.0	0

T A B L E A U I

N°	Planete		1969	TU	α (1950)	δ (1950)	(p Δ_α)	(p Δ_δ)	(O-C)	
32.			okt.	9.00767	$4^h\ 3^m 22.116$	+ 6°26'38."68	9.160n	0.737	0.0	0
33.			okt.	9.04271	4 3 21.694	+ 6 26 25.72	8.738n	0.735	0.0	0
34.	43	Ariadne	sep.	9.05938	2 7 45.793	+18 19 22.52	9.213n	0.590	0.0	0
35.			sep.	10.02648	2 7 33.347	+18 19 31.92	8.994n	0.580	0.0	0
36.			okt.	4.98090	1 52 3.063	+17 15 10.56	7.844n	0.606	0.0	0
37.			okt.	5.01010	1 52 1.079	+17 15 2.02	8.817	0.608	0.0	0
38.			okt.	6.98576	1 50 7.153	+17 4 28.40	8.400	0.609	0.0	0
39.			okt.	7.02538	1 50 4.700	+17 4 16.49	9.120	0.617	0.0	0
40.			okt.	8.96389	1 48 9.532	+16 53 13.19	8.210n	0.612	0.0	0
41.			okt.	10.95104	1 46 8.336	+16 41 15.11	8.514n	0.614	0.0	0
42.	51	Nemauza	okt.	11.02223	4 15 43.718	+ 9 40 32.42	9.045	0.704	0.0	0
43.			okt.	11.06774	4 15 43.147	+ 9 40 13.30	7.505	0.702	0.0	0
44.	137	Meliboea	sep.	8.95208	23 34 48.142	+ 9 0 28.48	8.287n	0.709	+3.0	+9
45.			sep.	9.93993	23 34 10.687	+ 8 51 34.68	8.636n	0.710	+3.0	+9
46.	324	Bamberga	sep.	8.87999	22 35 45.536	- 1 53 49.25	9.001n	0.804	+0.6	+6
47.			sep.	8.90729	22 35 43.836	- 1 53 37.71	8.467n	0.804	+0.6	+6
48.			sep.	9.88698	22 34 44.796	- 1 47 53.79	8.865n	0.803	+0.6	+6
49.			sep.	30.81499	22 18 35.544	+ 0 5 34.06	8.915n	0.789	+0.6	+6
50.			sep.	30.84549	22 18 34.619	+ 0 5 42.63	7.426n	0.790	+0.6	+6
51.	349	Dembowska	mart	9.93646	10 52 19.347	+17 22 54.72	8.176	0.619	0.0	+1
52.			mart	12.88127	10 49 52.030	+17 29 28.08	9.012n	0.608	0.0	+1
53.	354	Eleonora	maj	15.02534	17 31 51.201	+ 1 59 58.68	7.746n	0.774	0.0	0
54.			jun	10.95076	17 10 51.296	+ 2 16 5.16	8.481	0.772	0.0	0
55.	532	Herculina	maj	17.05510	17 35 1.067	- 8 7 46.31	8.910	0.844	0.0	0

TABLE DES MATIERES