He concluded that observations which become available after the compilation of FK3 will result in a very small correction to the position of the equator.

STOY asked if the minor planets should still be observed with the transit circles.

FRICKE replied that this was desirable.

CLEMENCE remarked that the observations of the sun should be continued at least until the results of the minor planets observations are established, but that in the long run the solar observations might prove to be a waste of time.

RABE pointed out that the Eros observations were not on any uniform system. Most of the observations were made in 1930–31 and were tied in to the system of the Katalog der Anhaltsterne. He also pointed out that the study was not carried out for the purpose of determining the systematic corrections but only done for the purpose of checking that there existed no undue correlation with other results.

HERGET remarked that in the dynamical solution Rabe made he had to have the sun's orbit included and put in a declination correction to leave the dynamics of the problem free.

FRICKE thought that it would be useful at some future date to reduce the Eros observations again, making a careful check on tying the reference system into the FK3 and FK4 system.

VYSSOTSKY wanted to know if Dr. van Herk's Equatorial Africa observations contributed to the correction to the declination, as these observations were made for this purpose.

FRICKE replied that they would make use of the van Herk catalogue.

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Observation on the Astrolabe of Fundamental Stars of Both Hemispheres

ANDRÉ DANJON
Observatoire de Paris, Paris, France

The merits of the O.P.L. impersonal astrolabe as a fundamental instrument are discussed. A comparison of the results obtained in both right ascension and declination with the astrolabe O.P.L. 12 in 1957 and 1958 demonstrates the degree of consistency of the observations. The immediate need is for an astrolabe in active service in Quito which, with astrolabe stations at Paris, Algiers and Wellington, would form a chain sufficient to link up all the fundamental stars from $-70°$ to $+77°$.

IN an important, but quite forgotten, paper, S. C. Chandler pointed out, as far back as 1887, the advantages of the method of equal altitudes of stars over the method of meridian transits either for the determination of the time and the latitude, or for the improvement of the catalogue of fundamental stars. One can prove the conclusions of Chandler in the following way.

From the recording of the time of transit of a certain number of fundamental stars, through a circle centered at the zenith (almucantar), one can compute their zenith distances. The clock correction and the latitude will then be obtained from the right ascension and the declination found for the zenith. One gets the best possible determination of the zenith when the observed stars are equally distributed on the circumference of the almucantar. Then the individual deviations due to catalog errors appear unambiguously.

Moreover, if for this purpose one uses the impersonal prismatic astrolabe (Danjon 1954, 1958) the zenith distance is constant. Hence, as B. Guinot recently showed, it is possible to connect right ascensions and declinations in a chain process so that all the stars of the observable zone referred to a homogeneous system.

On a transit instrument, one observes transits across a small circle very close to a great circle, the difference being the collimation C. The pole of this circle (west pivot) is approximately the point $\delta=0°$, $H=6$ hr. Let m and n be its differential coordinates (Bessel notations), and Δ the clock correction. From the recording of a certain number of transits, one can compute three unknowns that can be c, $m+\Delta$, and n. But in this case, the observations are not made over the entire circumference of the circle, of which we wish to find the pole, but only on about a quarter of it, for actually the zenith distance of observed stars seldom exceeds 45° towards the north or the south. Therefore, one can say *a priori* that the determination of the circle is not so good with a transit instrument, as with an astrolabe, and that individual deviations are not detected with the same certainty.

In practice, these drawbacks are overcome by measuring the collimation and the inclination of the axis of the transit instrument. This is done by pointing the instrument towards collimators and towards a mercury surface. But in this case, the conditions in which the instrument is used are very different from those which exist when it points towards stars. Thus, there is a lack of homogeneity in the data which are to be reduced.

What we have said of the chain adjustment in the

case of an astrolabe helps us to establish the conditions under which such a connection would be permissible in the case of a transit instrument!

(1) The collimation should remain constant throughout the night (as is the case with the angle of the prism).

TABLE I. Comparison of the right ascensions obtained in 1957 and 1958. The difference given is $a = \Delta\alpha_{1957} - \Delta\alpha_{1958}$ and $a \cos\delta$. Unit: 0s001. The sign of $\Delta\alpha$ is that of astrolabe minus catalog. Stars from FK3.

n°	$\Delta\alpha_{1957}$	$\Delta\alpha_{1958}$	a	$a\cos\delta$
16	+ 49	+ 49	0	0
27	− 9	− 7	− 2	− 2
32	+ 50	+ 34	+16	+ 8
1030	+ 28	+ 30	− 2	− 1
42	− 18	− 23	+ 5	+ 4
1032	− 18	− 18	0	0
46	+ 28	+ 32	− 4	− 2
63	+ 39	+ 55	−16	− 7
1054	+ 12	+ 9	+ 3	+ 2
1068	+ 20	+ 11	+ 9	+ 8
87	+114	+100	+14	+ 4
89	+ 5	+ 6	− 1	− 1
99	− 22	− 1	−21	−12
1089	− 5	− 26	+21	+20
1094	− 4	− 17	+13	+12
1096	+ 54	+ 45	+ 9	+ 4
122	− 13	− 20	+ 7	+ 4
129	+ 3	+ 9	− 6	− 3
144	− 11	− 21	+10	+ 9
174	− 6	− 9	+ 3	+ 3
175	− 12	− 8	− 4	− 2
182	− 15	− 23	+ 8	+ 4
211	− 11	− 1	−10	− 9
1157	+ 19	+ 13	+ 6	+ 3
237	+ 11	+ 3	+ 8	+ 4
279	− 7	− 20	+13	+12
280	+ 55	+ 31	+24	+14
292	+ 48	+ 50	− 2	− 1
296	− 30	− 29	− 1	− 1
317	+ 21	+ 25	− 4	− 2
1239	+ 6	− 2	+ 8	+ 7
355	+ 42	+ 40	+ 2	+ 1
358	+ 10	+ 16	− 6	− 4
371	+ 7	+ 11	− 4	− 4
398	+ 4	+ 11	− 7	− 4
403	+ 59	+ 65	− 6	− 2
405	− 13	− 15	+ 2	+ 2
416	− 3	+ 4	− 7	− 4
417	+ 3	+ 7	− 4	− 2
422	− 1	− 18	+17	+15
447	+ 13	+ 16	− 3	− 2
456	+ 1	0	+ 1	+ 1
1318	− 12	− 16	+ 4	+ 4
467	− 1	+ 4	− 5	− 3
472	− 13	− 11	− 2	− 1
500	− 10	− 2	− 8	− 4
550	0	− 3	+ 3	+ 1
1397	− 4	+ 3	− 7	− 4
1396	− 12	− 8	− 4	− 4
571	+ 25	+ 24	+ 1	+ 1
598	+ 15	+ 17	− 2	− 1
618	− 10	+ 6	−16	−15
627	+ 1	+ 5	− 4	− 2
1440	− 30	− 25	− 5	− 4
639	− 39	− 36	− 3	− 1
685	+ 29	+ 6	+23	+10
714	− 12	− 8	− 4	− 1
1515	+ 5	+ 10	− 5	− 4
1521	− 6	+ 3	− 9	− 7
759	+ 56	+ 40	+16	+ 4
758	− 7	− 6	− 1	− 1
767	− 7	− 20	+13	+ 6
1539	+ 20	+ 1	+19	+18
782	+ 3	0	+ 3	+ 2
783	− 25	− 39	+14	+ 6
803	+ 2	+ 8	− 6	− 3
809	− 56	− 63	+ 7	+ 3
1572	− 25	− 26	+ 1	0
1575	+ 11	+ 10	+ 1	+ 1
830	− 16	− 20	+ 4	+ 2
836	+ 1	+ 1	0	0
853	+ 11	+ 22	−11	− 5
852	− 14	− 17	+ 3	+ 3
859	+ 3	− 14	+17	+16
863	− 1	+ 13	−14	− 6
869	− 12	− 23	+11	+ 8
882	+ 19	+ 22	− 3	− 1
881	− 5	− 8	+ 3	+ 3
893	+112	+137	−25	− 6
899	+ 6	− 8	+14	+ 8

Stars from FK3 Supp. (Numbers given are from the General Catalog).

n°	$\Delta\alpha_{1957}$	$\Delta\alpha_{1958}$	a	$a\cos\delta$
94	+52	+54	− 2	−1
1136	+ 4	− 3	+ 7	+7
2836	+ 6	+ 1	+ 5	+3
3759	+45	+52	− 7	−2
4858	+44	+40	+ 4	+2
6259	+17	+18	− 1	−1
6288	+57	+43	+14	+4
6556	−33	−36	+ 3	+3
8826	0	− 5	+ 5	+3
8965	+15	+14	+ 1	+1
9581	+43	+36	+ 7	+4
12496	+ 2	− 5	+ 7	+6
12646[a]	+54	+64	−10	−4
12761	+19	+21	− 2	−1
14086	+ 2	− 6	+ 8	+7
15875	+16	+28	−12	−7
16985	+20	+20	0	0
17225	−11	−17	+ 6	+6
18504	+ 8	+14	− 6	−3
19742	0	− 4	+ 4	+3
22398	+42	+29	+13	+7
25362	0	+ 7	− 7	−4
26475	+19	+24	− 5	−3

[a] GC 12646. Position corrected from the FK3 Supplement.

TABLE II. Comparison of the declinations obtained in 1957 and 1958. The difference given is $d = \Delta\delta_{1957} - \Delta\delta_{1958}$. Unit 0″.01. The sign of $\Delta\delta$ is that of Astrolabe minus Catalog. Stars from FK3.

$n°$	$\Delta\delta_{1957}$	$\Delta\delta_{1958}$	d
27	−10	− 5	− 5
42	+16	+13	+ 3
1032	−22	−26	+ 4
46	−20	−15	− 5
66	+ 8	+11	− 3
1068	− 4	−19	+15
87	−24	−24	0
89	− 7	− 7	0
1089	+ 5	0	+ 5
1094	+24	+24	0
144	+ 4	+18	−14
174	−12	−10	− 2
211	+22	+12	+10
1173	+25	+28+	− 3
269	+ 6	0	+ 6
279	− 9	− 7	− 2
296	0	− 4	+ 4
1239	+14	+ 3	+11
358	+ 5	−35	+40
371	−11	−10	− 1
403	+13	+ 2	+11
405	− 7	− 7	0
422	+15	+ 8	+ 7
1304	+20	+ 4	+16
1318	−12	− 2	−10
466	−23	−28	+ 5
472	+18	+12	+ 6
550	− 4	+12	−16
1396	+34	+40	− 6
1400	0	− 1	+ 1
618	0	− 4	+ 4
1440	−31	−33	+ 2
1465	+55	+57	− 2
703	− 3	−10	+ 7
714	−21	−13	− 8
1515	+ 4	+ 2	+ 2
1521	+14	+ 6	+ 8
759	− 4	− 4	0
1539	− 5	+ 3	− 8
809	−21	−15	− 6
1575	−18	−23	+ 5
852	+ 7	+ 4	+ 3
859	+ 3	+ 3	0
869	−38	−29	− 9
881	−13	−11	− 2
893	+14	+ 5	+ 9

Stars from the FK3 Supp. (Numbers given are from the General Catalog)

$n°$	$\Delta\delta_{1957}$	$\Delta\delta_{1958}$	d
1136	−10	− 8	− 2
3759	+ 8	+19	−11
6259	+ 4	+12	− 8
6288	+ 8	+10	− 2
6556	− 7	−14	+ 7
8965	− 8	− 7	− 1
10707	−15	−12	− 3
12496	−15	−23	+ 8
14086	+15	+20	− 5
15162	+15	+15	0
17225	+ 2	+ 5	− 3
22802	+21	+14	+ 7
26569	+ 9	+ 9	0

(2) There should be an invariable mark somewhere towards the west (by analogy with the zenith defined by the mercury surface in the astrolabe).

Actually, though, the collimation of the classical transit instrument depends upon the temperature and the direction towards which the instrument is pointing, and lateral collimators have not given satisfactory results, at least until now (Danjon 1958). Most frequently, meridian marks are used as azimuth references. But then, one of the following two cases occurs: If the objective has a short focal distance, the direction of the mark is geometrically insufficiently defined; if the focal distance is large, the direction is optically unstable because of the heterogeneity of the atmosphere. The transit instrument is certainly an excellent instrument of interpolation to connect stars of similar right ascensions, but the impersonal astrolabe is to be preferred for the determination of systematic errors in the catalog by means of observations of stars with very different right ascensions and declinations.

Tables I and II, taken from Guinot, show the fidelity of the O.P.L. impersonal astrolabe used as a fundamental instrument. Since July, 1956 the same groups of fundamental stars have been observed. These groups are connected in chain, and the corrections to the catalog positions are separately computed each year from July to July. We now have results of two complete years for 103 stars. We have therefore two independent values of the correction $\Delta\alpha$. Let a be their difference. The mean quadratic value of the products $a\cos\delta$ is 0.006 sec. Therefore, the standard deviation of the mean of these corrections is 0.003 sec. In a few years, the correction to the positions of these 103 stars will be known within 0.001 sec. The standard deviation in declination will be 0″.02. For 400 other stars of the Paris zone now observed, the standard deviations will be 0.005 sec and 0″.05. Their number will soon be 900. This will furnish material of exceptional quality for the checking of the fundamental catalogue.

The astrolabe O.P.L. 12 of the Paris Observatory ($\varphi = 49°$) is assigned especially to catalog observations. The same work could be done with those which are set up in Algiers (+38°) and Wellington (−41°). If the necessary funds were found, a fourth astrolabe could shortly be put into service in Quito ($\varphi = 0°$). We shall show that such a chain would be sufficient to link up all the fundamental stars from −70° to +77° in a homogeneous system. Actually, the observable zones have the limits given in Table III.

The situation is not as propitious for the declination as it is for the right ascension because the method of

TABLE III.

Paris	in α	+24° to +77°	in δ	+20° to +45° and +71° to +78°
Algiers		+12° to +64°		+ 8° to +29° and +56° to +66°
Quito		−27° to +27°		−29° to −13° and +13° to +29°
Wellington		−70° to −16°		−71° to −61° and −35° to −13°

equal altitudes of stars does not allow us to determine the declinations of stars at their greatest digression ($-\cos S=0$) or near it ($|\cos S|<0,4$). Table III which corresponds to $|\cos S|=0,4$, shows that the following gaps would remain in declination: $-61°$ to $-35°$, $-13°$ to $+8°$, $+45°$ to $+56°$, $+66°$ to $71°$; but there are the following overlapping zones, which are large enough.

For Wellington-Quito:	$-29°$ to $-13°$
For Quito-Algiers:	$+13°$ to $+29°$
For Quito-Algiers-Paris:	$+20°$ to $+29°$.

Besides, one can add to the program all the stars for which: 0,2 0,4 0,2 $<|\cos S|<$ 0,4 provided that they are observed a large number of times.

Finally, the installation of a fifth astrolabe at a latitude of approximately $\varphi=60°30'$ would allow us to extend the measurement of both coordinates up to the immediate vicinity of the northern celestial pole.

Carrying out such a program implies that a very close agreement should be reached among the participants in order to prepare the observations and to make up the groups to be observed (which should have the greatest possible number of stars in common).

The following arrangements should be made:

(1°) In Paris, the astrolabe O.P.L. *n* 12° should be kept in service and assigned to catalog observations. The astrolabe *n* 1° would remain assigned to time and latitude determinations.

(2°) In Algiers, the program of the astrolabe *n* 8° should be modified. To routine determinations (time latitude), observations of groups for catalog work would be added. Routine groups are already adjusted by the observations done for the International Geophysical Year.

(3°) In Quito, the astrolabe *n* 13° and some auxiliary equipment are still to be set up. It would be desirable that Schmitt be in charge of carrying out the observations and have authority over the staff.

The program should include routine observations (two groups every night) and catalog observations (as many groups as possible).

(4°) In Wellington ($\varphi=-41°$), the astrolabe *n* 2° was used by the "Seismological Observatory" during the I.G.Y. In a letter of October 22, 1958, Dr. Hayes, Director of this Observatory, asked me what was the most useful work to be undertaken with the astrolabe at the end of the I.G.Y. I suggested in my reply, of November 18, that he continue the observations of the groups adopted during the I.G.Y. and that he add some groups for the purpose of studying the catalog. I have not yet received a reply from Dr. Hayes, but I presume that he would accept to participate during a few years in this program under a plan similar to that proposed for Quito.

(5°) The only permanent Observatory located at a latitude close to 60°30′ is the Observatory of Turku University in Finland (60°27′). I do not have at my disposal sufficient meteorological data to decide whether this location is suitable or to suggest another one.

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DISCUSSION

SCOTT reported on the limiting magnitude obtainable with the Washington meridian circles. With the 6-in., ninth-magnitude asteroids and stars were extremely difficult to observe. With the 7-in., Ceres, Pallas and Vesta had successfully been observed during the past winter and 12–15 observations had been obtained of Juno which at the beginning of the observing season was as faint as 9.4 mag.

CLEMENCE asked if sufficient observations could be obtained of the minor planets to determine the equinox and the equator.

SCOTT said this was doubtful, at least in the case of the equinox, which requires observations of the minor planets at quadrature. These observations are difficult to obtain because of the twilight conditions. He believed that enough opposition observations could be obtained of the minor planets to give an equator solution over a period of 5–6 years. An equator solution had been made a few years ago from a series of 6-inch observations of Ceres and Vesta from 1928–1935. Most of the observations had been made within $2\frac{1}{2}$ hours of opposition. The equator solution gave a value which agreed within 0″.05 with the solution obtained from observations of the Sun, Mercury, and Venus. Mr. Jackson of the U. S. Naval Observatory was in the process of making a new equator solution from a more extensive series of observations.

STOY remarked that Vesta had been observed successfully with the Cape 6-inch meridian circle over a number of years, the series going back to 1928.

CLEMENCE remarked that a very good determination of the equinox could be obtained from combining minor planet observations made with several meridian circles provided these programs had a sufficient number of bright stars in common.

STOY asked about the role of photographic observations of the minor planets such as in the Russian proposal on the observations of Ceres, Pallas, Vesta, and Juno.

CLEMENCE remarked that the photographic observations can be as important as the visual, provided that

the reference stars can be tied in sufficiently with the bright stars.

BROUWER stated that in order to separate the equinox correction from the correction to the longitude in the orbit it would be necessary to extend the meridian circle observations of the minor planets over a period of several months around the opposition. For this reason it is doubtful if the photographic observations would add much to solve the over-all problem, if they are too much restricted to the opposition.

DANJON did not think it looked very favorable to use the astrolabes for this problem. As it had been pointed out, it would be necessary to follow the asteroids until long after opposition when they will not be bright enough to be observed with the astrolabe unless the instrument was increased to much larger dimensions. This would decrease its accuracy which has hitherto been its value for fundamental observation.

VASILEVSKIS remarked that the Lick proper motion program covers a large range in magnitude, from about 8 to 17.5 magnitude. On each plate there will be approximately 15 to 20 AGK2 or AGK3 stars which would mean that the system could be reduced quite rigorously to FK3 or FK4; with two different exposure times using gratings, as is currently being done, it would be possible to measure the asteroids on the plates in a system close to the AGK2 or AGK3 system.

FRICKE agreed that it would be much better to use the method outlined by Vasilevskis connecting the minor planets directly to the AGK stars. If the Yale Catalogue was used it would be necessary to reduce to the GC system and finally to the FK3 or FK4 without knowing exactly what happens to the magnitude errors.

SCOTT felt that the minor planets should definitely be observed to see if they would determine the equinox and equator point. He said he would have as much confidence in such a determination as in one relating the daytime observations to the nighttime system on account of the difficulty of observing the day stars near the position of the sun.

CLEMENCE remarked that it should not be forgotten that the equator point cannot be uniquely determined from photographic observations because they are not referred to the vertical. This was discovered by Brouwer some years ago.

DANJON discussed the possibility of extending the catalog now being made for the Paris Zone to the whole sky in order to get the same system of right ascension and declination. This would be possible if four astrolabes could be put into operation. Besides the Paris astrolabe now in operation, the other astrolabes would be in Algiers, Quito and Wellington, New Zealand. While there is an astrolabe in Wellington he had not been able to get any response from the Superintendent of the Seismological Station in regard to obtaining such observations. At the meeting in Moscow, Danjon had proposed a much more ambitious program in which astrolabes would be located at every 15° of latitude. Because of the large overlap between successive zones this would establish a very accurate system, but he felt the plan was too ambitious, as it would be too costly to get all these instruments in operation and find qualified personnel. With the four instruments located in the places already mentioned, there would be a sufficient overlap to extend the system of the Paris catalog to −70° declination. This plan would be particularly successful in establishing the right ascensions. For the declinations there would be some difficulties on account of indeterminacy in declination in certain cases, but even so there would be sufficient overlap to get a more or less complete system for the zone −70° declination to +57°. It would be desirable to have another station at a latitude of 60°30′ north because this would make it possible to determine the declinations to the pole.

FRICKE felt that four astrolabe stations would not be sufficient, especially if the positions of the stars in the southern sky should be improved to the standards of the northern hemisphere. He recommended that additional astrolabes be installed in South America and that the observatories in South Africa also participate in the program. Since it is possible to reduce the astrolabe observations very quickly to apparent places by means of modern computers such work could be carried out elsewhere for the southern stations if the reduction work made them hesitate in participating in the program. Another point which Fricke wanted to bring up was whether it would be possible to build larger astrolabes to obtain stars down to 7.5 magnitude. With present astrolabes only a part of the fundamental stars and the stars of N30 or FK3 Sup. can be obtained.

DANJON agreed that it would be desirable to increase the number of astrolabes beyond the four he had already mentioned. He had previously discussed with Dr. Rutllant the possibility of setting up an astrolabe in Chile. This would be desirable in view of the longitude difference with Wellington and if Santiago was chosen as the station the difference of 7° in latitude would also be important. He had investigated the possibility of going further south than Wellington (Latitude −41° 17′) to islands in the southern part of the Indian Ocean but he had found the climates not suitable for an extended observational program.

DANJON continued by saying that more astrolabe stations at various latitudes and longitudes were also important in the study of the motion of the poles, in particular if the motion of the south pole corresponded to that of the north pole. It would also be important to study a little better the Kimura term which he thought was a local instrumental effect rather than an effect of latitude variation. With the astrolabe it is possible to determine the two coordinates of the pole at one place which would make it important to have the stations at different latitudes, but not necessarily of different longitudes. In the past longitude determina-

tions used the meridian marks which are difficult to stabilize.

DANJON concluded by saying that if the Cape Observatory would participate in a program then Wellington, Cape, and the South America station would form an important chain.

STOY felt that their participation would not only be a matter of instrumentation but also of manpower. Perhaps another solution would be to locate an astrolabe at the Boyden station because of its association with Hamburg and Uccle.

FRICKE remarked that if Dr. Stoy would consider having an astrolabe at the Cape, perhaps a recommendation could be made in regard to sending a young astronomer from the northern hemisphere to do the observing. He would prefer to have such a person at the Cape where the staff is already acquainted with fundamental positional work, which would not be the case at the Boyden Station.

STOY remarked that this was a question on which he had no authority to make a decision. He said he would discuss it with Dr. R. v. d. R. Woolley, the Astronomer Royal, and perhaps it would be possible to send personnel from Herstmonceux to the Southern Hemisphere.

DANJON agreed with Dr. Fricke that it is very important to have an astrolabe located where there is a tradition in fundamental astronomy. He also pointed out that it was very essential that the instructions going with the instrument be followed rigorously because they were obtained after 10 years of experience at the Paris Observatory. This would also insure that the same system of observations was used in the different places. If an astrolabe should be located in South Africa he would prefer to see it located at the Cape Observatory.

STOY remarked that an astrolabe at the Cape Observatory was a question of manpower, which is being utilized to the utmost and therefore prevents the staff from taking on any additional load.

DANJON explained that it would not be possible to construct a larger astrolabe at the present time. The principal feature of the astrolabe is the constancy of the angle of the prism, which in the present instruments have not changed more than 0".1. The actual variations are of the order of 0".02 to 0".03 notwithstanding considerable temperature variations during the course of observations. These are the variations for a prism of 10 cm and it is not certain that it would be possible to keep the temperature as uniform in a larger prism. Danjon remarked that he was willing to examine this, but it would have to wait until the optical and instrument shops were finished with the new meridian circle, which he hoped would be completed in 1960.

CLEMENCE asked if materials other than glass could be considered for the prism.

DANJON explained that it might be possible to use a combination of quartz plates cemented together, but he was doubtful whether the same stability of the angle of the prism could be obtained. The reason he did not believe in using quartz plates for the prism was that there would be air between the plates through which the light beam would be passing, which would not be the case in the solid glass prism. He remarked that on the surface of glass or quartz there always exists a layer of air of 5- to 10-mm thickness with a temperature different from the surrounding air. Such a temperature gradient gives rise to refraction which may cause deviations of several seconds of arc in the beam if the rays do not come in perpendicular to the surface. The only remedy he could think of would be to fill the prism box with helium which has a ten times smaller index of refraction and a much higher coefficient of heat conductivity than air. There would be a difficulty of retaining the pressure of the helium because it would seep through the walls of the prism. A solution would be to replenish the helium, but this would make the instrument rather complicated.