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COMMUNICATION FROM THE OBSERVATORY AT LEIDEN.

Report of the director of the Observatory at Leiden for the year 1927.

1. *General.*

Professor HERTZSPRUNG returned to Leiden on May 29 after a visit of about five months to the Harvard College Observatory and other american observatories.

Dr. VAN DEN BOS was attached to the staff of the Union Observatory, Johannesburg, as a chief assistant from Januari 1, 1928, and therefore from that date left the Leiden observatory, though for formal reasons he remains nominally a member of our staff, and consequently no successor has been formally appointed. Mr. H. VAN GENT, however, takes his place as the representative from Leiden at Johannesburg.

During the two years and a half that Dr. VAN DEN BOS has represented the Leiden Observatory at Johannesburg he has done much and very important work, which is highly appreciated.

The agreement between the observatories of Johannesburg and Leiden, which was mentioned in my report for 1923 (*B. A. N.* II. 46, p. 31) remains unaltered, and it is confidently expected that under the directorate of Mr. WOOD the cooperation between the two observatories will be as cordial and effective as it has been under his predecessor Dr. INNES.

Mr. N. W. DOORN took part in the Dutch expedition to Gellivare to observe the eclipse of the sun on June 29, and was absent from Leiden in connection with the preparations for this eclipse from April 13. He returned to Leiden in the beginning of July.

The director attended the meeting of the International Geophysical and Geodetic Union at Prague from 2 to 10 September.

Amongst the foreign astronomers who paid a visit to the Leiden observatory were Lt. Col. F. J. M. STRATTON and Mr. H. E. WOOD. M. A.

The total number of persons shown round the observatory, generally on saturday afternoons, during the year was 737, of whom 338 were shown the moon and other objects at night.

Buildings.

Several rooms in the observatory and the dwelling houses of the staff were painted. The dome of the

photographic refractor was also painted on the inside, the outside being left over for 1928. One of the boilers of the central heating installation was renewed.

In one of the small domes on the roof a pillar was built for the azimuth instrument, which has been ordered from the firm of COOK, TROUGHTON AND SIMMS at York.

Library.

The books on the shelves were compared with the catalogue.

Six books were found missing, while eleven books missing at the time of the preceding comparison have been recovered.

The library contains about 6500 books in about 8000 volumes, and about 760 periodicals and publications of observatories and institutions in about 9000 volumes.

2. *Instruments.*

Meridian circle. The instrument has been in good working order throughout.

To facilitate the determination of collimation an arrangement was made by which a small mirror and lamp can be mounted on the eyepiece.

Zenith telescope. A new object glass of 90 mm. aperture was ordered from ZEISS for this instrument. A new tube, corresponding to the larger aperture, was made in our workshop.

The *photographic refractor* was painted and cleaned.

The *Schilt microphotometer* has been in regular working order. A new galvanometer was acquired for use with this instrument.

Two similar instruments, which had been made for the observatories at Harvard College and at Lund, have been tested here.

3. *Observations and reductions.*

Astrometric Department.

Meridian Circle. The work on the programme of reference stars for Prof. SCHLESINGER's photographic plates of the zones 55° to 60° was completed.

The total number of zones secured during the year

is 51, on 49 nights, containing 297 observations of fundamental stars and 1162 observations of programme stars in both coordinates.

During the year 26 observations of Polaris were taken.

Determinations of collimation, both with the mercury trough and by reversing on the meridian marks, and of run were regularly made.

The inclination and the azimuth have once been readjusted. The slow change in the inclination, (west pier lowering), which has been noticed during the last six years, still continues, though a stable constitution seems now to be nearly reached.

Reductions. The reductions of the reference stars for Prof. SCHLESINGER have been completed, and the results communicated to him. The number of stars observed is 1073, the average number of observations is 3 in each coordinate. The mean error of one observation is

$$\begin{aligned} \text{in R. A. } & \pm 0.050 = \pm 0.40 \text{ (m. e.)} \\ \text{in Decl. } & \pm 0.54 \end{aligned}$$

A discussion of the accidental and systematic errors of these observations will soon be published in the *B. A. N.*, together with the resulting right ascensions and declinations.

The *red stars* observed in 1919–21, and their proper motions, have been published in Part 1 of Vol XV of the *Annals*. A discussion of the proper motions has been given in the *B. A. N.*

The reductions of the observations of the reference stars for the *Selected Areas* are well advanced.

Dr. HINS has carried out several investigations relating to the instrumental errors of the meridian circle, of which the results will soon be ready for publication.

The *southern fundamental stars* observed from 1880 to 1898 are being prepared for publication by Dr. OORT. The catalogue will soon be ready for the printers.

Zenith telescope. The instrument was out of use for a considerable part of the year, the object glass being removed. New values of the divisions of the levels were determined by Mr. SANDERS in November.

Universal instrument. Mr. SANDERS measured azimuths in elongation of stars between the pole and decl. + 70°. On 57 nights 78 west elongations and 91 east elongations were determined, and on 79 nights 149 determinations of the zero-point were made from observations of Polaris. The reductions are nearly completed. In the zero-point and the azimuth of the mark large irregularities were found which must probably for the greater part be ascribed to motions in the pillar. These results show that a high pillar,

however massive it may be, is unsuitable for fundamental work of high precision.

Measures of plates of Pleiades. Two pairs of plates were completely measured and reduced. The reduction of the plates measured in the preceding year was completed. The measures on eight pairs of plates have now been completely reduced, and relative proper motions have been derived. A complete card catalogue of these measures has been prepared. A table of the 334 best proper motions of stars between the approximate limits of magnitude 10^m and 14^m shows that the mean error of one of these proper motions in one coordinate is ± 0.003 yearly. The measures are being continued.

Statistical investigations.

Dr. OORT carried out a comprehensive investigation on the rotation of the galactic system. In connection with this new secular parallaxes were determined, and a new determination of the constant of precession and of a correction to NEWCOMB's motion of the equinox, were made, based on proper motions in galactic latitude. These investigations have been published in the *B. A. N.*

Dr. OORT further undertook some investigations concerning the dynamics of the stellar system, which are not yet concluded.

The *solar eclipse* of June 29 was observed with the special purpose of determining the relative positions of the centres of the sun and moon. Owing to cloudy weather the observations have been only partly successful, the central part of the eclipse being lost. The observations have been published in *B. A. N.* 131.

The *transit of Mercury* was observed on Nov. 10, but the sun was covered by cloud a few seconds before the third contact.

4. *Astrophysical Department.*

Photographic Refractor. The following numbers of plates were taken:

Object	Nr. of plates		Nr. of exposures	Total time of exp.
	G.	O.		
B. D. + 75° 752...	17		533	711
TU Mon.	3		4	193
Pleiades	19		30	658
RW Tau	1		40	193
Castor C	29		971	2265
B. D. + 6° 1309...	1		2	6
Praesepe	1		1	90
RR Lyrae	7		233	140
2 ^h 49 ^m 8 ^s } (1900).	2		2	50
+ 55° 2' 8"				

Object	Nr. of plates		Nr. of exposures	Total time of exp.
	G.	O.		
Σ 2873.....	2		77	109
RS Ori.....		1	3	20
RZ Cnc.....		1	3	28
AB And.....		1	2	7
SW Tau.....	34	1	50	383
RR Leo.....	2		44	213
H. D. 138213....	5		158	100
<i>Total</i>	123	4	2153	5166

The observers were

G. Mr. H. VAN GENT,

O. Mr. P. TH. OOSTERHOFF.

Castor *C*, B. D. 6°1309, and Σ 2873 (faint component) are spectroscopic double stars which were investigated to ascertain whether they are eclipsing variables. Castor *C* was already in 1926 found to be an eclipse variable. Further plates were taken to improve the light curve. Of Σ 2873 no eclipse could be observed. Of B. D. + 6°1309 only one experimental plate has been taken.

The plates of TU Monocerotis and RS Orionis were taken with an objective grating to determine the differences of magnitude of the comparison stars used by Prof. HERTZSPRUNG in his estimates on Harvard plates.

The plates of the Pleiades were taken partly for photometric purposes, partly to determine proper motions by comparison with plates taken in 1899 to 1910.

The plate of Praesepe was taken to ascertain the magnitude that can be reached with the instrument in an exposure of an hour and a half. This was found to be 15^m.

The star H. D. 138213 was photographed to ascertain whether it is a cepheid, which appeared possible according to the published spectroscopic elements. No sign of variability was found.

Double camera. Mr. DOORN has taken 47 double plates for photometry.

The observations for effective wavelengths have been reduced and the results were published in the *B. A. N.*

Messrs. OORT and DOORN made experiments on the polarisation of the light of nebulae by taking photographs through nicol prisms. The experiments have not yet given a definitive result, and are being continued.

Microphotometer. The number of images measured is as follows

	G.	V.	K.
RR Lyr.....	105		
SW Tau.....	112		
Σ 2873.....	138		
B. D. + 75°752 ..	342	4083	
H. D. 138213....	369		
Castor <i>C</i>	864		
TV Mon.....	411		
α Vir.	117		
44 <i>i</i> Boo.....			2410
<i>Total</i>	2458	4083	2410

The observers were

G. Mr. H. VAN GENT.

V. Mr. H. VROOM.

K. Mr. G. P. KUIPER.

The plates of α Virginis have been taken in Johannesburg and those of 44 *i* Bootis in Potsdam. The other plates have been taken in Leiden.

Visual estimates of variable stars on photographic plates were made by Professor HERTZSPRUNG during his stay at the Harvard College Observatory. The total number of estimates, including those made in 1928 is about 12500, of 35 different stars. The reduction of the estimates of eclipse variables is completed, and that of cepheids is well advanced.

After his return to Leiden Prof. HERTZSPRUNG has made 1224 estimates of three variables on the Johannesburg plates of the region of η Carinae.

Dr. OORT and Mr. DOORN have in December commenced observations with an apparatus constructed by Mr. BABCOCK, and consisting of a Fabry-Pérot *étalon* in front of a rapid camera, for the purpose of determining the intensity of the green Aurora line. On two nights rings produced by the Aurora line were photographed.

An investigation on the stationary calcium lines was published by Mr. BOK in the *B. A. N.*

5. *Observations at Johannesburg by Dr. VAN DEN BOS* from 1926 Dec. 1 to 1927 Dec. 31.

Visual observations. 26½-inch, 9-inch and 4-inch refractors.

Double stars. On 35 nights 3413 stars down to the ninth magnitude have been finally examined, of which 247 were found double within AITKEN's limits, including 160 new pairs. The totals of the systematic survey are now: 17965 stars examined, 1112 double stars, 608 new pairs. In addition to these a large number of stars have been preliminarily examined, which

will later be finally investigated in nights of very good definition.

The number of new discoveries was 353, bringing the total to 1030.

The number of measures of new and known pairs was 2066, bringing the total since Dr. VAN DEN BOS' arrival in Johannesburg to 4253 measures of 1957 pairs. These will be published in a forthcoming volume of the Annals. The total number of visual measures of double stars made by Dr. VAN DEN BOS at Leiden, Neubabelsberg, Greenwich and Johannesburg is now 7300.

Satellites of Saturn. The observations were much hampered by imperfect working and repairs of the driving mechanism. The number of measures is 68, including 25 of Minas, 25 of Enceladus referred to Thetys and 18 of Thetys referred to Rhea.

Comets. One observation of ♁ Reid, 2 of ♁ Blathwayt, 3 of ♁ Neujmin and 29 of ♁ Pons-Winnecke. The reduction of the latter is not yet completed, the others have been published in *U. O. C.* 73.

Occultations of 11 stars and one of Saturn were observed. 163 observations the *undulations of the sun's limb* were made at the request of Prof. HORN D'ARTURO.

Photographic observations, Franklin Adams telescope. The following plates were taken

	<i>Nr. of plates</i>	<i>Total time of expos.</i> h m
η Carinae	20	8 25
Crux	4	2 0
♁ Pons-Winnecke	9	20
Variable stars	1	15
	34	11 0

Much of Dr. VAN DEN BOS' time was devoted to the publication of INNES' Catalogue of southern double stars. This work is now completed.

6. Theoretical department.

Jupiter's Satellites. Dr. BROUWER's discussion of the observations of phenomena of the Satellites made at Johannesburg from 1908 to 1926 was completed. A summary of the results was published as Dr. BROUWER's inaugural dissertation. The detailed publication as Vol. XVI, part 1 of the Annals is in the printers' hands.

The discussion of the longitudes derived from photographic plates and other sources has been delayed by the discovery and correction of a mistake in the discussion of the old eclipses of Satellite III, from which a new determination of the mass of IV, agreeing with

ADAMS' determination, had been derived (*B. A. N.* 4). The discussion is now nearing its completion, and the results will soon be ready for publication. The agreement of the final results with those derived independently by Dr. BROUWER from entirely different observations appears to be excellent.

Rotation of the earth. An investigation was carried out on the secular accelerations and the fluctuations in the motions of the moon, the sun, Mercury and Venus, including a determination of corrections to the adopted longitudes and mean motions of these bodies. The results have been published in *B. A. N.* 124, 127 and 130. The ratio Q of the fluctuations in the sun and planets to that in the moon was found to be

$$(1) \quad Q = 1.25 \pm .08$$

The large value $Q = 2.62$ found previously from the Satellites of Jupiter, is thus not confirmed. This value depended to a large extent on the old eclipses of III. After the correction of the error referred to above it is found that the observations of Jupiter's satellites are compatible with the value (1). There remain, however, unexplained discrepancies in the longitudes of the satellites, which must be due to causes originating within the system of Jupiter.

Other investigations. Dr. WOLTJER's investigations on Hyperion were concluded. The theory and the reduction of the observations will soon be published as Vol XVI, part 3 of the Annals.

Dr. WOLTJER further published investigations on the problem of the cepheids and on the excitation of nebular lines.

7. Staff.

The staff of the observatory is at the present moment *) constituted as follows:

Director: Prof. Dr. W. DE SITTER.

Adjunct-director: Prof. Dr. E. HERTZSPRUNG.

Conservators: Dr. J. WOLTJER.

Dr. J. H. OORT.

Observers: Dr. C. H. HINS.

(Dr. W. H. VAN DEN BOS.)

(H. VAN GENT.)

Chief Assistant: C. SANDERS.

Assistants: N. W. DOORN.

J. J. RAIMOND.

G. P. KUIPER.

P. TH. OOSTERHOFF.

Chief of computing department: D. GAYKEMA.

Computer highest grade: G. PELS.

*) March 1, 1928.

Computers 1st class: ... J. C. GAYKEMA.
J. M. KRIEST.
M. D. SCHEPPER.

Computers 2nd class: ... E. W. DE ROOY.
Miss C. H. DE NIE.
H. M. SWAAK.
B. G. MEKKING.
L. GAYKEMA.

Chief-instrumentmaker: H. ZUNDERMAN.

Instrumentmaker: ... J. H. KASTEN.

Stoker and Carpenter: P. DE HAAN.

In addition to these three supernumerary computers have been employed throughout the year.

Dr. VAN DEN BOS, though for purely formal reasons nominally still belonging to the staff of the Leiden Observatory, is acting as chief assistant of the Union Observatory at Johannesburg.

Mr. H. VAN GENT takes Dr. VAN DEN BOS' place as the representative of the Leiden Observatory at Johannesburg.

Dr. OORT is engaged in theoretical researches in the department of fundamental astronomy.

Dr. HINS is in charge of the observations with the meridian circle. The regular observations are made by Messrs HINS, D. GAYKEMA and KRIEST, while Messrs SWAAK and MEKKING read the circle microscopes.

Mr. SANDERS is in charge of the zenith telescope and the universal instrument.

Mr. D. GAYKEMA is in charge of the reductions. The established computers with the exception of Messrs PELS, DE ROOY and SCHEPPER, as well as two of the supernumerary computers, work under his direct supervision.

Prof. HERTZSPRUNG is in charge of the astrophysical department. Mr. DOORN observes with the ZEISS double camera. The observations with the photographic refractor are made by Mr. OOSTERHOFF. One of the supernumerary computers is also attached to this department.

Mr. KUIPER observes with the 10-inch refractor.

Dr. WOLTJER is in charge of the theoretical department. Messrs PELS, DE ROOY and SCHEPPER are attached to this department.

Mr. OORT is in charge of the library, assisted by Mr. KRIEST.

Mr. ZUNDERMAN has the general direction of the instrumentmakers workshop, and is in charge of the photographic refractor and the double camera.

Mr. KASTEN is in charge of the other instruments, and has the general care of the buildings.

Mr. D. GAYKEMA assists the director in his administrative duties.

Dr. W. E. KRUYTBOSCH has continued to work in the observatory as a volunteer assistant.

8. Publications.

Vol. XV, Part 1 of the *Annals* was published during the year, entitled: A catalogue of the positions and proper motions of 1533 red stars, by Dr. C. H. HINS.

The following numbers of the *B. A. N.* contain communications from the observatory at Leiden. When more than one paper by the same author is contained in one number, the number of papers is added in parentheses.

- B. A. N.* 114. W. H. VAN DEN BOS (2).
115. J. WOLTJER [103].
116. Report of the director.
117. W. DE SITTER [12].
118. W. H. VAN DEN BOS (4).
120. J. H. OORT.
122. B. J. BOK [393].
124. W. DE SITTER [451].
126. W. H. VAN DEN BOS.
127. W. DE SITTER.
129. W. DE SITTER.
130. C. H. HINS,
W. DE SITTER.
131. Observations of the solar eclipse
of June 29.
132. J. H. OORT [667].
133. J. H. OORT (2).
134. E. HERTZSPRUNG.
135. D. BROUWER.
136. W. H. VAN DEN BOS.
138. J. WOLTJER.
139. W. H. VAN DEN BOS,
Observations of the transit of
Mercury of Nov. 10.
140. N. W. DOORN.

It does not appear necessary to repeat here the full titles of these communications.

Some of these communications have also been published in the Dutch language in the *Verlagen van de Koninklijke Akademie van Wetenschappen te Amsterdam*, Vol. XXXVI. The pages of this volume are in those cases added in italics to the name of the author above.

In addition to the above the following papers were published by members of the staff during the year.

W. DE SITTER. Over den astronomischen tijd, *Hemel en Dampkring*, XXV. 5, p. 129.

Over den astronomischen tijd en de wentelende aarde, *Haagsch Maandblad*, VIII, 5, p. 495.

On the rotation of the earth and astronomical time, *Nature*, supplement to Vol. 121, p. 99.

E. HERTZSPRUNG. On objective gratings for photometric use, *Harvard Bulletin* 845, p. 1.

Note on a peculiar object of short duration, *Harvard Bulletin* 845, p. 2.

J. H. OORT. Niet lichtgevende materie in het sterrenstelsel, *Hemel en Dampkring*, XXV, pp. 13 and 60.

Rotatie en bouw van het melkwegstelsel, *de Natuur*, 47, pp. 238 and 241.

W. H. VAN DEN BOS. Dubbelsterwerk aan de sterrewacht te Johannesburg, *Hemel en Dampkring*, XXV, 3, 85.

D. BROUWER. Diskussie van de waarnemingen van Satellieten I, II en III van Jupiter. Inaugural dissertation, *Leiden, Ydo*, 1927.