Report of the Director of the Observatory at Leiden for the period from May 1 1919 to August 31 1921

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COMMUNICATION FROM THE OBSERVATORY AT LEIDEN.

Report of the director of the Observatory at Leiden for the period from May 1 1919 to August 31 1921.

1. *General Remarks.*

The last report from the Observatory at Leiden was published in 1913.*) The present report treats of the period beginning with my appointment as director in the spring of 1919.

When the late director, Prof. E. F. VAN DE SANDE BAKHUYZEN, died suddenley on March 3 1918, I was charged with the intermediate directorate of the Observatory. At the same time the Curatorium of the University requested me to report on the state and the organisation of the Observatory. In the report which I presented in compliance with this request on the 17th of April, I included plans for a reorganisation of the Observatory. After the approval of these plans by the Minister of Instruction, Arts and Sciences, and the voting of the money necessary for the first steps towards their execution by Parliament, I was definitively appointed director on April 30 1919.

The Observatory after its reorganisation consists of three departments, viz: the departments of astrometry or of fundamental astronomy, of astrophysics, and of astromechanics, or the theoretical department. The chiefs of two of these departments are adjunct-directors, the chief of the third department being at the same time director of the observatory.

On July 20 1919 Professor EJNAR HERTZSPRUNG was appointed adjunct-director of the astrophysical department. He entered upon his post on September 10 1919, and on July 1 1920 was made a professor extraordinarius in the University.

The post of adjunct-director of the astrometric department has not yet been definitively filled. Professor J. C. KAPTEYN offered his help in planning and organising the work of this department. This offer was gratefully accepted and on November 1 1920 Prof. KAPTEYN was temporarily charged with the adjunct-directorate of the department of fundamental astronomy.

The plans for the reorganisation of the observatory were not carried into effect all at once, but by successive steps. A stage is now reached when it is desirable to realise the complete plans. It is hoped that means will soon be provided to make this possible.

2. *Buildings.*

The plans for the reorganisation of the Observatory included a partial reconstruction of the main building, providing more room for offices, a larger library and reading room, a new workshop, and storing room for old records. Further the domes of the 6-inch Merz equatorial telescope, and the west tower will be renewed, and two new small domes will be added. One of these is to contain a universal instrument, the other a new instrument for the astrophysical department, about which more details will be given below. For the astrophysical department rooms for offices, dark rooms and rooms for measuring apparatus will be built, adjoining the dome of the photographic refractor. The dwelling houses for various members of the staff will be improved or newly built. Of all this only a comparatively small part has so far been completed. The work of the observatory has been seriously hampered by the fact that several parts of the old building were under reconstruction, and thus not available for use, while the new parts were not yet completed.

3. *Instruments.*

Meridian circle. The instrument is in perfect working order. Probably as a consequence of the driving of long poles into the ground for the foundation of a new part of the building adjoining the meridian room, the azimuth relatively to the meridian marks increased in August 1912 to $-0^s.8$. In September it was reduced to $-0^s.15$ by means of the adjusting screws. At the same time the inclination of the axis was corrected.

*) Verslag van den Staat der Sterrenwacht te Leiden en van de aldaar volbrachte waarnemingen van 19 September 1910 tot 15 September 1912, uitgebracht door E. F. VAN DE SANDE BAKHUYZEN, Leiden 1913.

The azimuth of the meridian marks is regularly verified by observations of Polaris. The marks are very constant.

In September 1921 it was found that the focussing of the microscopes on the circle gave rise to difficulties in some positions of the instrument. This was ultimately traced to a slight increase of the distance between the two piers, so that the axis of the instrument had a little play in the direction from east to west. It is possible that this may be due to the excessive drought of the summer of 1921. A slight adjustment of one of the V's was sufficient to completely remedy the defect.

A new table of wire-intervals was derived from more than 400 transits of equatorial stars. These intervals are used for the reduction of the observations for the current programme.

The supports for the mirrors and lamps for the illumination of the field and the circles, as well as the outer coverings of the piers, were painted between July 6 and 10 1920 (a rainy period). At the same time the wiring for the illumination was rearranged.

It has throughout the year 1920 been difficult to adequately protect the instruments against the fine dust produced by the demolishing of parts of the building, that were to be renewed. During the worst period, from July 18 to August 14 1920, the meridian circle was entirely put out of use, the seams of its case being pasted over with strips of paper, to prevent the dust from reaching the instrument.

On July 14 1920 it was noticed that the screw moving the R. A. wire did not run smoothly. On removing it, small scratches were found on the breast-plate. The screw was cleaned and the breast repolished in our workshop. After replacing it, the periodic errors were investigated by means of a collimator provided with a micrometer. Afterwards also an extensive series of transits of Polaris was taken. From these observations Dr. ZWIERS derived the formula of correction:

$$\Delta = +.^s0206 \sin x - .^s0225 \cos x + .^s0029 \sin 2x - .^s0032 \cos 2x,$$

which represents the errors well. This formula is used for the reduction of the observations since July 14 1920.

Travelling-wire micrometer. In September 1919 Mr. J. VOÛTE, now of Weltevreden, presented to the Observatory his registering micrometer with driving clockwork by GUSTAV HEYDE, which had been used by him in measuring parallaxes with the meridian circle of the Cape Observatory. Preliminary measures were at once taken to adapt the micrometer to our meridian circle and the necessary adapting pieces were designed by the instrumentmaker ZUNDERMAN. As however the making of these brass pieces and the corresponding counterpoises would require some time, and also the observers were not yet trained in the use of the registering micrometer, is was decided for the first programme of observations still to use the old method of registering. It is intended to take the new micrometer into use as soon as the present programme is practically finished.

The clock Hohwü 17 had not been cleaned since it was put in its present position in a niche in the pier of the 10-inch refractor in the hall of the observatory, in December 1898. On May 2 1918 Mr. DE CASSERES of Rotterdam came to the observatory to take the clock down for cleaning, the pendulum remaining in its position untouched. After cleaning, renewing the oil which had thickened in places, and repolishing one of the axes which showed slight signs of wear, the clock was replaced on the same day. The run for some months after this operation was somewhat irregular, but has since become fairly constant.

The mean-time clock Mahler stopped on Christmas day 1920, and again in January 1921. It has been dismounted, cleaned and repared by Mr. DE CASSERES, and has functioned well since then.

Photographic Refractor. This instrument of 330 mm. aperture and 516 cm. focal length was built in 1896 especially for the determination of parallaxes. At the present time, now that many instruments of much longer focal length and in better climates, are engaged in parallax work, an instrument of this size can no longer be considered as adequate for this work. It is however not easy to draw up a satisfactory programme of astrophysical work for an instrument of this kind.

One of the simplest kinds of observations that can be made with it, without requiring many auxiliary apparatus, is photographic photometry by means of intra-focal images. The intra-focal images given by the object glass are however rather irregular in shape, and also the curvature of the focal surface gives rise to large corrections, depending on the position of the star on the plate, which are troublesome in photometric work, except for variable stars, which can always be taken in the same position on the plate, and compared with the same comparison stars.

Nevertheless it has proved to be possible to use the intra-focal images for photometric purposes. A grating has been made in our workshop, that can be placed before the objective to determine the photometric scale.

The instrument as a whole is in excellent working order. The driving mechanism has a periodic error amounting to a few seconds of arc, the period being one revolution of the wormwheel. With considerable trouble the instrumentmaker ZUNDERMAN succeeded in keeping the error within reasonable limits, so that for intra-focal work it is not of much importance.

The 10½ inch visual refractor by Clarke-Repsold. This instrument of 266 mm. aperture and 380 cm. focal length is in good working order. A rotating wire gauze has been fitted to the dewcap. The driving clock and the dome were under repair in November 1920 and other small repairs were made when necessary.

The 6-inch refractor by Schröder was dismounted and cleaned in 1918. It has not been remounted, as the dome of the west tower in its present state is not fit for use.

The 6-inch refractor by Merz has temporarily been fitted with the driving clock of the 7-inch refractor. The instrument has been used by Dr. LUYTEN for observations of variable stars. It is also occasionally used for showing the moon and other objects to visitors.

The old 7-inch refractor by Merz., which had been dismounted in 1885, and replaced by the 10½-inch refractor, has been given in loan to the new observatory at Lembang. It was sent to Java in October 1920. The object glass was returned to the firm of Carl Zeiss, Jena for repolishing, as the glass showed some small patches as a consequence of erosion by the acid vapours from the wood of the box in which it was kept for 35 years.

The universal instrument by Repsold. This instrument showed irregularities in the reading of the horizontal circle, which seemed to point to a certain amount of play in the vertical axis. The instrument was dismounted and cleaned. The consistency of the readings was found much improved after this.

Instruments of Mr. Sanders. In August 1914 Mr. C. SANDERS, of Matuba, Portuguese Congo, presented to the observatory a universal instrument by Sartorius, together with three chronometers and a refractor of 80 mm. aperture by Zeiss. These instruments remain in the possession of the donor, who receives them in loan from the observatory. With this instrument Mr. SANDERS made in 1917-18 a series of determinations of the latitude of Matuba by the Horrebow-Talcott method, of which the results were published in *M. N.* 1920, p. 445. During his stay in Europe Mr. SANDERS visited the observatory at Leiden, and drew up a programme of observations for the determination of absolute declinations free from refraction, by a method invented by him *), and specially adapted for stations in low latitudes. Mr. SANDERS is at present engaged in carrying out these obvervations at Matuba.

Zenith telescope by Wanschaff. This instrument belonging to the observatory is used by Dr. DE JONG for determinations of the variation of latitude by the Horrebow-Talcott method on behalf of the Geodetic Survey. The instrument is good, but the aperture is so small that only on very good nights it is possible to observe stars fainter than 6.8 mag. The floor of the observing house has been renewed. The errors of the screw have been investigated, and were found larger than previously.

The adjustment of the instrument is very stable. The following determinations of azimuth in both positions of the axis were made.

Date	West	East.
1915 Sept. 9	+ 0.6	− 0.0
1916 Nov. 2	+ 0.3	− 0.6
1918 July 24	+ 0.5	− 0.2
1919 July 15	− 0.6	− 0.5
1920 Feb. 22	− 0.2	− 0.2
1920 Aug. 20	+ 0.2	0.0

With a view to the small accuracy of the determinations the agreement is satisfactory.

Since May 1918 995 pairs were observed on 117 nights.

Microphotometer. The observatory has on loan from the Astrophysical Observatory at Potsdam a Hartmann microphotometer, which is used for measuring the plates obtained with the photographic refractor.

The new double photographic camera by Zeiss. A new photographic camera is under construction at the works of CARL ZEISS, Jena. It will consist of two identical telescopes, mounted side by side. The object glasses are astrotessar lenses of 104 mm. aperture and 52 cm. focal length, so that fields of $20° \times 20°$ can be taken on plates 20×20 cm. The telescopes will be provided with moving plate-holders as first used by Schwarzschild („Schraffier-Kassette"), actuated by electro-magnets, by which it will be possible to spread the light of each star equally over a square, or rectangle, of which the sides can be adjusted, for the two telescopes separately, to any length up to 1 mm. Gratings to be put before the object glass will also be provided. It is hoped that the instrument will be ready early in 1922.

4. *Observations and reductions.*

Astrometric department.

General remarks. At its foundation in 1860 the director KAISER assigned to the observatory as its principal task the making of fundamental observations of stars. The instrument which he designed for these observations, and its auxilliary apparatus, as well as the directions that he drew up for the execution and the reduction of the observations, were eminently fitted for their purpose. Also the observations made under his directorate, and that of his successor, H. G. VAN DE SANDE BAKHUYZEN, belong to the best of their time, and many valuable contributions

*) See *The Observatory*, 1917, July, p. 271 and 1919, Feb. p. 90.

to the theory and practice of meridian observations have emanated from the Leiden Observatory in those days.

The staff of observers and computers has, however, always been insufficient. The reduction of fundamental observations, especially a reduction of so refined a character as was deemed necessary by KAISER and his successors, requires a staff of computers in addition to, and considerably exceeding in strength, that of the observers. With the existing small staff, very much smaller than at any other observatory undertaking fundamental work, it was impossible that the reductions should even approximately keep pace with the observations. The result has been a considerable arrear in the reduction and publication of results. Of the great series of fundamental observations undertaken since the foundation of the observatory practically no final results have as yet been published.

Observations from 1864—1868. This series consists of 166 stars, 134 of which are those given in the Nautical Almanac of the time, and 34 other bright stars from the Greenwich catalogues. In Vol. VI of the Annals final values*) of the observed zenith distances on each night are given. Final values for the declinations have never been published. These could be derived with comparatively little trouble. A number of selected observations of about one half of the stars have been used in the derivation of the declinations of the stars for the European Triangulation, final values of which were published in Vol. II of the Annals, together with those of 21 circumpolar stars used for determining the latitude.

In Vol. I are given the times of transit reduced to the middle thread. The printed values however contain many errors, and the thread-intervals used in their derivation are unreliable. In order to derive reliable results an entirely new reduction, starting from the individual observed transits, would be necessary. Although most of the elements for such a reduction were derived by Dr. DE VOS VAN STEENWIJK for his investigation on the equinox of 1865.0, contained in Vol. XI of the Annals, still it would be a very large piece of work, requiring a vast amount of time and labour. Many observations of the same stars where made at the same epoch at other observatories, so that it is doubtful whether the result would repay the labour spent on it. This doubt is increased by the remarks made by KAISER himself regarding these observations in 1869.**) I have therefore, after mature consideration, decided not to expend any further labour on these observations.

*) Provisional values are contained in Vol. I.

**) Verslag van den staat der Sterrewacht te Leiden, 1868-1869, p.p. 13 and 17.

Polar stars. In 1870 KAISER planned the observation of about 80 stars near the North Pole, of which the desirability had been pointed out in the *Generalbericht* of the European Geodetic Survey in 1865. These observations, on a slightly altered programme, were begun in 1877, and completed in 1885. Each of the 84 stars has been observed in both culminations, in both positions and both states of the instrument (Clamp East and West, object glass and eye piece interchanged) both directly and by reflection. The number of observations in each case being 2, there are in all 32 observations of each star in both coordinates. The reduction of these observations has been practically completed for the last 10 years. The final results will, it is hoped, soon be published.

Southern Fundamental stars. During the years 1880 to 1898 observations have been made of 303 Southern fundamental stars, selected by the Astronomische Gesellschaft in 1877. Of each star there are 4 observations in each of 4 positions of the instrument. A considerable part of the reductions has been done. It is intended to complete the reductions and publish the results as soon as the exigencies of current work will permit.

Observations from 1903—1908. In 1900 a new programme of fundamental observations was drawn up, the observations of which were commenced in September 1903. It consists of 813 stars, the majority of which are fundamental stars. It further comprises zodiacal stars and stars culmlnating at equal zenith distances N. and S., as well as some stars culminating very near the zenith. These last two classes of stars were to be observed simultaneously with the zenith telescope, in order to investigate the flexure of the meridian instrument. With a view to the determination of the refraction all stars culminating N. of the zenith were to be observed in both culminations.

Of the observations of this extended programme about one fourth of the number were completed when I took over the directorate in March 1918. These observations were very irregularly distributed over the stars and over the different positions of the instrument. The corresponding observations at the zenith telescope were not yet commenced. The reductions were greatly in arrear. For the last 10 years the means of the readings had not yet been inscribed in the computation forms. Reductions to mean place had only been computed (not in duplicate however) for the first year (up to 1904 Oct. 15).

The completion of the programme would, at the same rate, take about 50 years for the observations alone. It has been pointed out already that the execution of fundamental work is beyond the resources of the Leiden Observatory. Even with its present staff

it would not be possible to make the reductions keep pace with the observations, if the latter were made at all assiduously.

Moreover the meridian circle of the Leiden Observatory no longer fulfills the requirements of modern fundamental work. The instrument itself, and its foundation, are excellent, but its position in the main building with its thick walls and unsymmetrical surroundings (in the east the high middle part, of which the walls become heated by the afternoon sun, in the west the low director's dwelling house) make it unreliable for fundamental work of the greatest refinement.

These considerations have led me to abandon fundamental work altogether, and to devote the labour of the meridian circle to problems which, though they may be of fundamental importance, can be solved by means of differential observations.

Red stars. As soon as the observing staff had been completed by the appointment of Mr. HINS, who assumed his duties in the beginning of September 1919, the first programme of this kind was taken in hand.

It consists of stars of the spectral types III, III?, *Ma*, *Mb*, *Mc* in Krüger's *Katalog Farbiger Sterne*, culminating between the equator and the zenith, in all about 1600 stars. These stars are observed in narrow zones. As far as was practically feasible the zones were taken between the declinations 0°—20°, 20°—30°, 30°—35°, 35°—40°, 40°—45°, 45°—52°.

Generally 9 or more standard stars are taken with each zone, 3 at the beginning, 3 in the middle and 3 at the end. The mean declination of the standards is the same as of the zone, but their range in declination often exceeds that of the zone by 5° or more on both sides. The preparation of the programme, and the training of the observers, took up the clear nights of the autum of 1919, and regular observations were commenced on 1919 Dec. 15. The following numbers of observations have been secured up to 1920 Sept. 1.

Observer	Standards	Red stars.
Z.	168	311
H.	296	593
G.	163	287
S.	30	37
Total	657	1228

These observations are distributed over 81 zones on 66 nights.

From 1920 Sept. 1 up to 1921 Sept. 15 the number of observations is:

Observer	Standards	Red stars.
Z.	29	62
H.	435	1230
G.	431	1130
Total	895	2422

These observations are distributed over 94 zones on 83 nights. *)

The observers at the telescope are:

Z: Dr. H. J. ZWIERS.
H: C. H. HINS.
G: D. GAYKEMA.
S: S. S. SMEDING.

The circle microscopes were read by Mr. J. M. KRIEST and Mr. H. M. SWAAK.

The reductions are entirely differential. As fundamental stars it has been found necessary to use many stars from BOSS' *Preliminary General Catalogue* in addition to those occuring in the national ephemerides. The times of transit from the paper strips are always inscribed the next morning. The reductions to mean place, instrumental corrections, refractions etc. are computed as soon as possible. Thanks to the assiduous application of Dr. ZWIERS, who is in charge of these reductions, and the staff of computers under his direction, it has, even in the summer of 1921 with its almost continuous clear weather, been possible to avoid arrears in the computations. Almost without exception the mean place for 1920·0 has been computed and chequed within a month after the date of the observation.

Several investigations regarding personal errors, clock corrections, and errors in the places of fundamental stars from BOSS' catalogue, have been undertaken by Mr. HINS.

In November 1920 Mr. HINS paid a visit to Berlin to copy from the archives of the *Kommission für die Geschichte des Fixsternhimmels* all observations of stars of our programme previous to 1900. Also observations after 1900 were collected from various catalogues. A card catalogue is being made of all our stars, giving all observations reduced to the equinox 1900·0.

Standard stars for selected Areas. The programme that will be taken up as soon as the observations of the red stars are completed, consists of the observation of the stars of the A. G. occuring on the Northern areas of the *Plan of Selected Areas*, supplemented in some cases by fainter stars from the B. D.

The co-operation of a few foreign observatories in this work has been requested, and in most cases kindly promised.

In the spring of 1921, when the programme of the red stars in the hours of R. A. then observable began to show gaps, a few nights were already devoted

*) From Sept. 16 up to the date of publication of this report about 1700 further observations of red stars have been secured. The programme is now completed. Much credit is due to the observers, especially to Mr. HINS and Mr. GAYKEMA, for their zeal in securing observations whenever the state of the sky is favorable.

to this new work. The following numbers of observations were secured.

Observers	Standards	S. A. Stars
H.	91	142
G.	102	149

Time service. Since the abandonment of fundamental work, the very constant rate of the principal clock Hohwü 17 has lost much of its importance. It is also no longer used as the standard time-keeper for the Navy, who from April 1 1921 take their time from the wireless signals of the Eiffel tower. The time service of the observatory could consequently be considerably simplified. Separate determinations of time are not made now, but now and then the correction and rate of the clock are determined from the fundamental stars observed in the regular course of the programme work.

Also the signals from the Eiffel tower are regulary recorded. Since January 1919 the day signals are taken instead of those at 11 p.m., the recording of which would interfere too much with the regular observing.

5. *Astrophysical department.*

Photographic refractor. The observing programme includes photographic photometry by means of intra-focal images, as explained above, and measures of double stars. Up to Aug. 31 1921 the following numbers of plates have been obtained. The observers were Dr. W. J. LUYTEN from October 21 1919 to June 6 1921, and W. H. VAN DEN BOS from June 24 1921.

Intrà-focal plates with grating: 46 plates. On the average there are 14 stars on each plate, with three exposures of each star. The plates have been measured by Prof. HERTZSPRUNG on the microphotometer. The measuring and reduction keeps pace with the observing.

Double stars: 54 plates of about 100 different stars, containing more than 2000 exposures. On the average each star is contained on two plates, and each plate contains about 20 exposures. Up to September 1 1921, 393 exposures had been measured. The accuracy is satisfactory.

RZ Cephei: 12 plates containing 251 exposures.

Other variable stars:	27	plates.
Neptune:	17	„
Other planets:	15	„
Comets:	6	„
Novae:	8	„
Trails of 80 and 81 Tauri:	6	„
Various objects:	58	„

Colour equivalents of bright stars. Prof. HERTZSPRUNG has completed a comprehensive investigation of all determinations of colour of stars brighter than the fifth magnitude, and north of declination — 5°. The M. S. of his paper, which also contains statistical investigations on the correlation between colour and luminosity, has been sent to the printers.

Most of these stars have been put on the observing list of the photographic refractor for photometry by intra-focal images. It is intended to compare the resulting photographic magnitudes with the visual magnitudes from the Postdam Durchmusterung in order to derive colour indices.

It is intended later to extend the programme to fainter stars, when the new camera with moving plate-holder will be available.

Photovisual magnitudes of stars in Praesepe. A number of plates of this cluster, taken with the 80 cm. refractor at Potsdam, and containing stars down to about the 11th magnitude, have been measured in the microphotometer by Mr. VAN DEN BOS. The measures and the reductions are completed, and the results will soon be published.

Other investigations. Several other investigations relating to magnitudes, colour equivalents, double stars, and other subjects, have been taken in hand by Prof. HERTZSPRUNG. Many of these are based on plates taken by him at Potsdam.

10½ *inch refractor.* In the period from May 1918 to June 1919 this instrument was used by Dr. DE VOS VAN STEENWIJK for measures of double stars and proper motion pairs from BURNHAM's lists. More than 500 observations were secured. The results have been published in *M. N.* vol. **80**, p. 223.

Mr. W. H. VAN DEN BOS started a new series of observations of double stars on October 6 1920. The observing list contains binaries with orbital motion, preference being given to those pairs for which an orbit can be computed, or an existing orbit improved in the near future. Also the principal stars of some pairs have been measured relatively to faint comparison stars, with a view to the determination of the variation of proper motion, and hence of the mass-ratio.

Up to Aug. 31 1921 301 observations of 104 pairs were secured. The accuracy of the observations, notwithstanding the short time of practice of the observer, is equal to the best that has been done elsewhere with instruments of this size.

Two orbits have already been computed and published.

6. *Theoretical Department.*

Theory of Jupiter's Satellites. In Vol. XII, Part. I of the Annals an outline was given of a mathematical theory of the satellites based on an intermediary orbit which includes the great inequalities (arising through the mutual commensurability of the mean motions) and treating the proper excentricities as variations from this intermediary orbit.

The numerical computations are based on assumed values of the mean motions and the masses. The intermediary orbit was completely computed, and developed in power series of the corrections to the assumed masses, in March 1919. The variations, including the motions of the proper perijoves, the libration, and the long-period inequalities of Class II, were ready in June 1919. The computations of the perturbations and of the terms of the second and third degree in the proper excentricities, are well advanced.

Theory of Hyperion. Dr. WOLTJER has given an exposition of the fundamental idea of this theory, based on the application of DELAUNAY's method, in his inaugural dissertation*) published in July 1918. Since then he has continued his investigations on the subject, and has published his results regarding the motion of the pericentre of Hyperion, and the terms depending on the first power of the excentricity of Titan. He is now investigating the perturbations of short period produced by Titan in the motion of Hyperion and the motion of the orbital plane of Hyperion. The theory is being compared with the observations of H. STRUVE at Babelsberg. The agreement is satisfactory. Publication of these results is soon to be expected.

Plates of Jupiter's Satellites In accordance with the plan of observations outlined in *History of the Cape Observatory*, p. xcviii, plates were taken at the Cape Observatory in 1913, 1914 and 1915, and at Greenwich in 1916, 1917 and 1918—1919. The Cape plates from 1913 have been measured and discussed, and the result published in *M. N.* Vol. **76** p. 448. Those from the years 1914 and 1915 were kept at the Cape during the war, and have only recently been received at Leiden. The plates from Greenwich were also sent to Leiden. The measurement of these plates has been delayed by the writer's absence in Switzerland, and also by the fact that during the building operations there was no suitable room available for placing the measuring apparatus. The computations of tabular places for all these series of observations is practically complete. The measurements will now, it is hoped, soon be commenced.

7. *Staff.*

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

Director: Prof. Dr. W. DE SITTER.
Adjunct-directors: Prof. E. HERTZSPRUNG.
Prof. Dr. J. C. KAPTEYN, (*acting*).
Conservators: J. WEEDER.
Dr. J. WOLTJER.
Observators: Dr. H. J. ZWIERS.
C. H. HINS.
Assistant: W. H. VAN DEN BOS.
Computers 1st class: J. C. GAYKEMA.
D. GAYKEMA.
S. S. SMEDING.
G. PELS.
Computers 2nd class: E. W. DE ROOY.
Miss C. H. DE NIE.
J. M. KRIEST.
H. M. SWAAK.
Chief-instrumentmaker: H. ZUNDERMAN.
Instrumentmaker: J. H. KASTEN.

In addition to these four supernumerary computers are employed.

From Oct. 6 1919 to April 2 1921 the director was absent on leave. Prof. HERTZSPRUNG acted as director during that time.

Prof. KAPTEYN has the general direction of the astrometric department.

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

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

Prof. HERTZSPRUNG is in charge of the astrophysical department. In the observations with the photographic refractor he is assisted by Mr. VAN DEN BOS. who also observes with the 10½ inch visual refractor, One of the supernumerary computers is also attached to this department.

The theoretical department is in charge of Dr. WOLTJER, under the general direction of Prof. DE SITTER. Mr. PELS and Mr. DE ROOY and one of the supernumerary computers are attached to this department.

Mr. WOLTJER also 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.

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.

8. *Publications.*

When I took over the directorate in March 1918 the following volumes of the Annals were wholly or partly printed, but not yet distributed:

Vol. X, Part 2: Doppelsternmessungen angestellt am Fadenmikrometer des 10½-Zölligen Refraktors von 1910 Aug. bis 1913 Juni, von J. VOÛTE.

*) Investigations in the theory of Hyperion, by J. WOLTJER, Leiden 1918.

Vol. X, Part 3: Untersuchungen über die Deklinationen und Eigenbewegungen von 163 Sternen, welche 1899—1906 am Zenithteleskop in Leiden beobachtet worden sind, von Dr. H. J. ZWIERS.

Vol. XI, Part 1: Sur un régulateur de LÉON FOUCAULT parfaitement isochrone et de construction simple et sur une tentavive de rendre cet appareil indépendant de la température, par Dr. J. H. WILTERDINK.

Vol. XI, Part 2: L'équinoxe pour 1865·0 déduit des observations du soleil 1864—68 de l'observatoire de Leyde, par J. E. DE VOS VAN STEENWIJK.

These parts were distributed. In the future the several parts of each volume will be distributed as they appear, and will not be combined to volumes. When a volume is completed a title page and index will be issued. Vol. IX is the last one that has been distributed as a whole. It contains papers from 1901 to 1915, and was distributed in 1918.

Of Vol. X, Part I the tables and the first part of the introduction were ready printed in January 1917. The M. S. of the second part of the introduction had never been received by the printers. Dr. PANNEKOEK with great kindness, for which we are much indebted to him, undertook to complete the introduction. The complete paper was printed off and distributed in 1919. Its title is:

Vol. X, Part 1: Beobachtungen am Meridiankreis in den Jahren 1899—1902 und deren Bearbeitung von Dr. E. F. VAN DE SANDE BAKHUYZEN und Dr. A. PANNEKOEK.

Further the following parts of the Annals were printed and distributed:

Vol. XI, Part 3: Die nördliche Milchstrasse, von Dr. A. PANNEKOEK (1921).

Vol. XII, Part 1: Outlines of a new mathematical theory of Jupiter's Satellites, by W. DE SITTER (1918).

Vol. XII, Part 2: Analytical and numerical theory of the motions of the orbital planes of Jupiter's Satellites (secular terms), by Dr. A. J. LECKIE (1919).

Title pages of Vols X and XI have been printed, and will be distributed at the first opportuniy.

The following parts are at present in the printer's hands:

Vol. XIII, Part 1: Note sur la réfraction a l'intérieur d'une lunette horizontale, dont la température varie proportionnellement à la hauteur; Détermination des constantes de la flexion du cercle méridien, par Dr. H. G. VAN DE SANDE BAKHUYZEN.

Vol. XIII, Part 2: Observations of variable stars, by Dr. W. J. LUYTEN.

Vol. XIV, Part 1: Mean colour equivalents and hypothetical angular semidiameters of 734 stars brighter than the fifth magnitude and within 95° of the north Pole, by EJNAR HERTZSPRUNG.

The following papers by members of the staff have been published in the period covered by this report:

W. DE SITTER: Theory of Jupiter's Satellites, I. The intermediary orbit, *Proc. Acad. Sci. Amst.* **21** p. 1156 March 1919.

Theory of Jupiter's Satellites, II. The Variations, *Proc. Acad. Sci. Amst.* **22** p. 236 June 1919.

On the possibility of statistical equilibrium of the universe, *Proc. Acad. Sci. Amst.* **23** p. 866 Nov. 1920.

The Einstein terms in the motion of the lunar perigee and node, *M. N.* **81** Nov. 1920.

De bouw van het sterrenstelsel, KAPTEYN's beteekenis voor de moderne astronomie, *de Gids*, July 1921.

EJNAR HERTZSPRUNG: Photographische Messungen von Doppelsternen von 1914·0 bis 1919·4. *Publ. Astrophys. Obs. Potsdam*, Bd. **24** II Nr. 75.

On the motion of the Magellanic clouds, *M. N.* **80** p. 782, 1920.

Over de kleur der Sterren, *Inaugural address*, May 1921.

J. C. KAPTEYN *): On the distribution of the stars in space especially in the high galactic latitudes. *Astrophys. Journ.* **52** p. 23, 1920.

J. WEEDER: De buiging der cirkels van een meridiaankijker, *Verslag Akad. Amst.* **26** p. 73, Mei 1919.

J. WOLTJER: The longitude of Hyperion's pericentre and the mass of Titan, *Proc. Acad. Sci. Amst.* **21** p. 881 Dec. 1918.

On the perturbations in the motion of Hyperion proportional to the first power of Titan's excentricity *Proc. Acad. Sci. Amst.* **21** p. 1164 March 1919.

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H. J. ZWIERS. Meridian observations of Nova Aquilae 3. *A. N.* **207** pp. 60 and 69, 1918.

C. H. HINS: On a change with the declination of the personal error in transit observations. *Proc. Acad. Sci. Amst.* Sept. 1921 (not yet published).

W. J. LUYTEN: Photographic positions of Neptune, obtained between March and May 1920, *M. N.* **80** p. 784.

Visual and photographic Observations of Nova Cygni 3, made at the Royal Observatory, *M. N.* **81** p. 61.

Note on the Cluster N. G. C. 6633, *M. N.* **81** p. 213.

The visual and photographic light-curve of V 18 = R Z Cephei 223564, *M. N.* **81** p. 398.

Observations of Variable stars, *Inaugural dissertation*, Leiden 1921.

W. H. VAN DEN BOS: The orbit of Σ 554 = 80 Tauri, *M. N.* **81** p. 474.

The orbit of the double star Σ 1834. *Proc. Acad. Sci. Amst.* **24** p. 72, June 1921.

*) In collaboration with P. J. VAN RHIJN.