

34. COMMISSION DE LA PARALLAXE SOLAIRE

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Much progress has been made since the last meeting of the Union in the measurement and reduction of photographic plates and in the reduction of micrometric observations obtained near the opposition of Eros, 1930-31. The reduction of photographs and measures which are dependent upon positions of secondary comparison stars have had necessarily to be postponed until the positions of these stars are available. In this report, the present position of the investigations is summarized.

1. *Reference Stars.* (a) *Primary.* The positions of these stars, based on meridian observations at several observatories, were published by A. Kopff, H. Nowacki and F. Gondolatsch in *Ast. Nach.* **241**, Nos. 5781-2 and **244**, Nos. 5852-3. The reduction of series of path plates, taken for the purpose of providing positions of secondary reference stars, and of series of Eros plates obtained with telescopes of astrographic focal length have shown that the positions of some of these stars are considerably in error. As is to be expected in view of their smaller average weight, the largest discordances are in the positions of some of the southern stars.

The number of suitably placed primary reference stars on a plate of area $2^{\circ} \times 2^{\circ}$ is, in general, about six to eight. An erroneous position for one star will appreciably impair the deduced position of Eros. The large amount of photographic material available will enable corrections to the positions to be derived which, whilst leaving unaltered the general system based upon the careful co-ordination of meridian observations, will improve its internal homogeneity. It is hoped to publish in due course a definitive list of corrections and it is recommended that any reductions based on the meridian positions of the primary stars should ultimately be revised by applying these corrections. The corrections from the Bergedorf plates alone have been published in *Zweites Bergedorfer Sternverzeichnis 1930-0: Nachtrag*; these corrections will be incorporated with other material for a definitive list.

(b) *Secondary.* The secondary reference star places will be based on series of path plates obtained at Bergedorf, Greenwich, Leipzig, the Cape and Lick Observatories. The positions of 4599 secondary reference stars down to -14° , based on plates covering an area of $5^{\circ} \times 5^{\circ}$ taken with the Bergedorf A.G. Astrograph, have been published in *Zweites Bergedorfer Sternverzeichnis 1930-0*. The position of the measurement and reduction at the other Observatories is as follows:

- (i) The Greenwich series of astrographic plates extending to declination -4° has been completely measured; plate constants have been computed and adopted and the conversion of the measured co-ordinates to right ascension and declination is in progress.
- (ii) The Leipzig series, extending to declination -13° , has been completely measured; plate constants have been computed and adopted and the conversion of the measured co-ordinates to right ascension and declination is approaching completion.
- (iii) The Cape series, covering the path from $+24^{\circ}$ to -25° has been measured at Greenwich. The reductions are progressing equally with those of the Greenwich series.

(iv) To strengthen the positions of secondary reference stars south of the equator, plates covering an area of $5^\circ \times 5^\circ$ and centred at declinations $-0^\circ.6$, $-10^\circ.8$ and $-15^\circ.1$ are being measured at the Lick Observatory. It is expected that the results will be available shortly.

North of declination -14° secondary comparison stars were selected by Dr Schorr. The comparison stars for the reduction of long-focus photographs covering this portion of the path have been selected at most of the co-operating observatories from this list. All stars in this list appearing on the various series of path plates and suitable for measurement have been measured, together with such additional stars as have been asked for by any co-operating observatory.

Relatively few observatories have plates with long-focus telescopes covering the portion of the path south of -14° . No selection of stars was therefore made for this region. Only those stars whose positions have been asked for by one or more co-operating observatories have been measured.

The several series will be combined together, as soon as the full results are available and the final positions published as the definitive catalogue of secondary reference star places.

2. *The Ephemeris of Eros.* The barycentric ephemeris of Eros has been published by Dr G. Witt: *Astronomische Abhandlungen, Ergänzungshefte zu den Ast. Nach.* 9, No. 1. The ephemeris covers the period 1930 Oct. 0.00 to 1931 June 3.00. The barycentric values for α 1930.0, δ 1930.0, $\log \Delta$ and for the reductions from the centre of the Earth to the barycentre, R_α , R_δ , are given at intervals of 0.25 days. The values of the aberration (R.A. and Dec.) and light time are given at intervals of 1.00 day.

Comparison between the ephemeris and observed positions derived from preliminary reductions of a number of photographs shows that at the beginning of October the ephemeris position requires correction in R.A. by about $+0^s.5$. The correction shows a progressive and regular decrease, becoming zero at the middle of January, reaching a stationary value of about $-0^s.08$ and then increasing again to $-0^s.04$ by the end of April. In declination, the correction is $+1''.0$ early in October, decreases regularly to a stationary value, $-2''.5$, early in December, then increases again and reaches a second stationary value of $+0''.4$ early in March, followed by a decrease to $-0''.2$ at the end of April.

The importance of a homogeneous series of reference star places to serve as a basis for the reduction of the observations for comparison with the ephemeris is emphasized by a discontinuity of between $2''$ and $3''$ in the residuals in R.A. about May 6, when the limit of the primary reference stars was reached and Hyderabad astrographic places were used.

The ephemeris errors are therefore reasonably small throughout the period covered by the observations. All observed places should be compared with this ephemeris. Directions, with examples, are given in the introduction as a guide to those who are not conversant with such matters.

The method of constructing the ephemeris is fully described by Dr Witt in the introduction. It is therefore not necessary to give details here. From all the material available it will be possible finally to derive definitive normal places, from which corrected elements of the orbit of Eros can be deduced. A series of twenty-three photographs of Eros, obtained at the Cape Observatory over as long an arc as possible (from 1933 June 29 to September 11) around the opposition of 1933 will serve as an additional control.

The work of revising the elements of the orbit of Eros, computing and applying

perturbations and finally computing the ephemeris has been a heavy one. The Commission is much indebted to Dr G. Witt and his assistant Dr von Schelling for the time and labour which they have devoted to this work.

3. *Measurement and Reduction of Observations of Eros.* The present state of the measurement and reduction of photographic plates and of the reduction of micro-metric observations are based on reports received from the co-operating observatories.

Photographic Observations.

Greenwich. The measurement of the following series of plates has been completed in both R.A. and Dec.:

- (i) The Greenwich series of 160 plates with the 26 inch refractor.
- (ii) The Greenwich series of 204 plates with the 13 inch astrographic refractor.
- (iii) The series of 52 plates obtained at the Radcliffe Observatory with the 24 inch refractor.
- (iv) The series of 41 plates obtained at the Melbourne Observatory with the 13 inch astrographic refractor.

In series (ii) and (iv), the standard co-ordinates of the reference stars have been computed and reductions are in progress. The reductions of series (i) and (iii) must be deferred until secondary reference star places are available.

The following series of plates are in course of measurement at Greenwich: (i) the Cape series of 478 plates, with the 24 inch Victoria telescope; (ii) the series of 60 plates obtained with the Yale photographic refractor in Johannesburg. Series of plates from the Harvard Station at Bloemfontein, from the Union Observatory, Johannesburg, and from the Sydney Observatory have been received at Greenwich for measurement.

Bergedorf. 10 plates obtained with the A.G. astrograph have been measured and reduced. 11 plates obtained with the 60 cm. refractor have been measured but not yet reduced. The measurement of the 22 plates obtained with the Lippert astrograph will be measured shortly.

Leipzig. The series of 32 plates obtained with the 30 cm. refractor has been measured and reductions completed. The comparison of the derived positions of Eros with the ephemeris is in progress.

Uccle. 9 plates obtained with the astrographic refractor have been measured and completely reduced. The measurement of the series of 45 plates obtained with the Zeiss astrographic triplet has been completed and the reductions are in progress.

Alger. The series of 119 plates obtained with the astrographic refractor has been measured and reduced and the results have been published (*J.d.O.* 15, No. 9, 17, No. 6). The 94 plates photographed through the glass have not been measured, owing to shortage of staff. The Director has promised to place these plates at the disposal of the Commission, if required. It is proposed to measure any plates which may fill in gaps in the other material available.

Catania. The measurement of 74 of the 86 plates obtained with the astrographic refractor has been completed. Most of these plates have been reduced and the positions of Eros derived. The completion of the work at an early date is anticipated.

San Fernando. The measurement and reductions of the 13 plates obtained with the astrographic refractor have been completed.

Praha. The measurement and reductions of the 16 plates obtained with the astrographic refractor have been completed and the results are in the press.

Pulkovo. The measurement and reductions of the 20 plates obtained with the

astrophographic refractor have been completed and the results published (*Pulk. Obs. Circ. No. 6, 1933*).

Allegheny. The measurement of the series of 146 plates obtained with the long-focus refractor has been commenced. The plates obtained on two nights have been measured.

Dearborn. The measurement of the 246 plates obtained with the long-focus refractor has been completed. The definitive positions of secondary comparison stars not being yet available, provisional reductions have been made using *Carte du Ciel* positions. The positions of about 200 images of Eros were used by Dr Wylie to derive the unperturbed orbit of Eros. The results of this investigation have been published in *Dearborn Publications*.

Lick. 15 foot camera: The measurement of 7 of the 12 plates is completed; the measures of one plate have been reduced. The measurement of the 73 Crossley reflector plates has not yet been commenced.

Washington. The 50 plates obtained with the 12 inch refractor have been measured. Both primary and secondary comparison stars were measured; reductions are necessarily delayed until positions of the secondary stars are available.

Van Vleck. The measurement of the series of 156 plates obtained with the long-focus refractor has been postponed until the positions of the secondary comparison stars are available.

Zé-Sé. The 44 plates obtained with the long-focus refractor have been measured. The measures have been published in detail (*Annales de Zé-Sé, 17, fasc. 6, 1932*). The reductions will be undertaken as soon as the positions of the secondary comparison stars are published.

Tokyo. 92 plates obtained with the long-focus refractor have been measured in one direction in each co-ordinate. Measurements in the second direction have been commenced.

Hyderabad. No recent report has been received but up to October, 1933, 34 of the 212 plates obtained with the astrophographic refractor had been measured. The computation of standard co-ordinates for 68 other regions had been made.

Cape. 532 plates obtained with the astrophographic refractor have been measured and completely reduced. 156 plates taken at large hour angles on nights where meridian plates were also available were measured in R.A. only; otherwise both co-ordinates have been measured. A preliminary discussion indicates a value of the solar parallax somewhat greater than $8''.80$, but corrections to the primary comparison star places must be applied to obtain a final value. The corrections may change the deduced value of the parallax by more than its probable error.

The Cape long-focus plates are in course of measurement at Greenwich.

Yale (Johannesburg). The measurement of the 59 plates obtained with the long-focus refractor is in progress at Greenwich.

Harvard (Boyden Station). The 71 plates obtained with the Bruce refractor have been sent to Greenwich for measurement. The measurement has not yet been commenced.

Union Observatory. The 176 plates obtained with the Franklin Adams telescope have been measured; three primary reference stars were measured on each plate and reduced by the method of dependencies. The measurement in greater detail was not possible with the available staff. The plates have been sent to Greenwich and will be measured with a large number of comparison stars. The photographs at large hour angles were made through a yellow screen on yellow-sensitive plates and should prove valuable as a control on the effects of atmospheric dispersion.

Melbourne. The 43 plates obtained with the astrographic refractor are being measured at Greenwich.

Sydney. The 17 plates obtained have been forwarded to Greenwich.

Cordoba. The measurement of the long series of about 300 plates obtained with the astrographic refractor has been delayed for various reasons. A start has recently been made and it is hoped that the measurements and reductions will be completed within about two years.

La Plata. The meridian series of 50 plates, obtained with the astrographic refractor, has been measured and a provisional reduction made. It is expected that the measurement of the remaining plates will be completed in a further period of six months.

No report has been received from the following Observatories: Bordeaux, Cambridge, Leander McCormick, Lembang, Swarthmore.

Micrometric Observations.

Berlin-Babelsberg. Preliminary reductions of observations on 14 nights were made and the results published in *Ast. Nach.* No. 5780. These positions were used by Dr Witt in his investigation of the orbit of Eros. The definitive reduction of the complete series (234 observations in x and 210 in y) will be undertaken as soon as the final positions of the reference stars are available.

Pulkovo. The observations with the 15 inch refractor, 34 in x and y , have been reduced with preliminary comparison star places and the results published in *Pulk. Obs. Circ.* No. 4.

Heidelberg. The observations on 15 nights with the 12 inch refractor have been reduced and the results communicated in manuscript.

Besançon. The results of the 15 sets of observations have been published in *J.d.O.* 14, No. 6, 92.

Arcevi. The 35 groups observed with the visual refractor have been reduced.

Padova. 118 groups were observed on 30 nights. Provisional results have been published in *Atti del R. Ist. Veneto di Sci. Lett. ed Arti*, 93, pt ii, 599. Secondary star places are required for the definitive reduction.

Milano. 97 groups were observed on 32 nights; primary comparison stars were mostly observed. The reductions have been completed but the results are not yet published.

Washington. 101 groups were obtained on 48 nights with the large visual refractor. The same comparison star was used throughout a single night. Provisional reductions have been made. The results were supplied to Dr Witt for use in his investigation of the orbit of Eros.

Union Observatory. The observations with the long-focus refractor (82 groups on 26 nights) have been reduced and the results published in *U.O.C.* No. 88, 1932.

La Plata. 48 groups were observed on 21 nights with the long-focus refractor. These have all been reduced and the results forwarded for publication in the *Ast. Nach.*

No reports have been received from Kwasan, Lisboa, Teramo and Wien.

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