HELIOMETER OBSERVATIONS FOR DETERMINATION OF STELLAR PARALLAX MADE AT THE ROYAL OBSERVATORY, CAPE OF GOOD HOPE

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Trieste

HELIOMETER OBSERVATIONS

FOR

DETERMINATION OF STELLAR PARALLAX

MADE AT THE

ROYAL OBSERVATORY, CAPE OF GOOD HOPE,

BY

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HER MAJESTY'S ASTRONOMER AT THE CAPE.

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1893.

INTRODUCTION.

Soon after I had the honour of being appointed Her Majesty's Astronomer at the Cape, in 1879, I directed the attention of the Lords Commissioners of the Admiralty to the fact that no adequate equipment for refined extra meridian observations existed at the Observatory. Before making further official proposals to remedy this defect I had the good fortune to procure, by private purchase, the Heliometer which I had used at Dun Echt, and in connexion with the expedition of Lord Lindsay (now the Earl of Crawford and Balcarres) to the Island of Mauritius in 1874, when I observed with it the opposition of the minor planet Juno,* and which I afterwards employed by Lord Lindsay's kind permission, in the Royal Astronomical Society's expedition to the Island of Ascension to observe the opposition of Mars in 1877.†

The instrument as employed at Mauritius and Ascension is fully described in the Dun Echt publications, Vol. II. For use at the Cape I could not obtain the original equatoreal mounting, and therefore ordered a new stand for the Heliometer tube and cradle from Sir H. Grubb of Dublin, taking advantage of the opportunity thus offered to have some alterations made on the instrument which previous experience had proved to be desirable. These alterations were chiefly in connexion with the slow motion of the tube in position-angle. In the original instrument the quick motion in position-angle was accomplished by turning a rod, which carried a pinion which acted on a wheel of which the Heliometer tube formed the axis. Slow motion was given by rotating this rod very slowly by means of a toothed wheel acted on by a tangent screw, but the effect was to create a certain amount of torsion of the rod before any rotation of the tube took place, so that there was wanting that immediate and precise response to the observer's action which is essential for easy and accurate measurement. I therefore planned the following arrangement.

At the end of the cradle next to the observer, there is fitted on the tube (or rather on one of the collars attached to the tube)

* Dun Echt publications, vol. ii.

† Memoirs of the R.A.S., vol. xlvi., pp. 1–172.

a ratchet wheel with square cut teeth. This wheel is so fitted as to turn smoothly on the collar, but, when the observer so desires, it can be clamped firmly to the tube by a handle coming down to the eye-end. A steel screw with a square-cut thread (such as Grubb uses for the driving screws of his Equatoreals) acts on the teeth of this wheel, whilst the pivots of this screw rest in bushes in a frame attached to the cradle. The screw is turned by bevel wheels acted on by a handle coming down to the eye-end. When the observer turns the handle the wheel slowly rotates; and, if the tube is clamped to the wheel, a smooth easy rotation is communicated to the tube. This slow motion as well as the Equatoreal mounting, and the driving clock were admirably constructed by Sir. H. Grubb and the instrument was in every respect efficient, stable, and convenient.

During a visit to some of the principal European observatories, before my departure for the Cape, I met Mr. W. L. Elkin, a student under Professor Winnecke, who was then engaged in preparing his "*Inaugural Dissertation*" for the Degree of Doctor of Philosophy at the University of Strasburg. The subject he had selected was the orbit and parallax of α *Centauri* and he applied to me for any observations of α *Centauri* as a double star, or any unpublished meridian observations of α β *Centauri* which I might find on the records of the Cape Observatory.* In the course of conversation I informed Mr. Elkin of my purchase of the Heliometer, and of the purposes to which I intended to apply it. He expressed much interest in my programme and his keen desire to take part in such work, It was finally arranged that, on the completion of his curriculum and on the arrival of the Heliometer, Dr. Elkin should come to the Cape and share my labours.

The Heliometer reached the Cape in the end of December 1880 (the Lords Commissioners of the Admiralty having defrayed the cost of transport), and I proceeded at once to erect it in an old observatory which had been built by Sir Thomas Maclear in 1847, to cover a small telescope by Dollond. This observatory is described in *Mem.* R.A.S., vol. xx., pp. 31-34. I had duly completed the necessary alterations of the building, and the adjustments of the instrument when Dr. Elkin arrived at the Cape, on 1881, January 31. The following month was spent in preliminary experiments, in the selection of stars of comparison, and in the preparation of a programme.

* These observations I supplied soon after my arrival at the Cape, and they are incorporated in his Dissertation "*Ueber die Parallaxe von α Centauri.*" Karlsruhe, 1880.

This settled, I was on the point of leaving for Durban and Aden to carry out the longitude operations connecting these places with the Cape, when I was suddenly recalled to England on urgent private affairs. I made new arrangements for the longitude work, so that when I returned to the Cape on 1881, June 30, I was enabled to take up the programme of the Heliometer observations at an earlier date than I originally intended. Dr. Elkin occupied my house in my absence, and remained as my guest, and as a member of my family circle until the completion of our programme. He sailed from the Cape on 1883, May 16. His work from first to last was a labour of love.

The results of the observations contained in this volume have been published in the Memoirs of the Royal Astronomical Society, vol. xlviii.; but in connexion with such work it is usual and desirable to publish sufficient details of the original observations to enable other Astronomers to verify the subsequent computations.

In the selection of comparison stars the conditions aimed at were:—

1. Symmetrical situation with respect to the star whose parallax is to be determined, that is to say, nearly at equal distances from it, and different in position-angle nearly 180°. As far as possible these position-angles should nearly coincide with the position-angle of the major axis of the parallactic ellipse, but when several pairs of comparison stars are employed this condition cannot of course be fulfilled.
2. Both comparison stars should be nearly of equal magnitude.
3. They should be stars having little or no proper motion.

The following are the positions of the comparison stars as determined with the Cape Transit Circle, and the adopted position-angle and distance from the principal star; the other existing observations reduced to the same equinox will be found in the *Mem.* R.A.S., *loc. cit.*

Star	Comp. Star.	α 1882·0.	δ 1882·0.	Mag.	Adopted Position Angle.	Adopted Distance.	
		h m s	° ′ ″		°	″	R
	a	14.26.29·30	−59.29.41·6	7	323·07	3836 =	298·1
α_2 Centauri -		31.35·77	−60.20.46·7	1			
	β	35.51·13	−61. 1. 7·8	7¼	142·24	3063	238·1
	a¹	18. 9·55	−60.13. 7·0	8	274·38	6012	467·2
	β¹	43.52·13	−60.21.23·4	8	90·39	5466	424·7
	a	30. 6·20	−58.36.56·7	6·9	354·27	6230	484·2
	b	33.43·37	−60.41.29·5	7½	168·45	4970	386·6
	a¹	25. 1·59	−60.16.42·8	8	274·73	2940	228·4
	b¹	14.37.52·90	−60.21.59·8	8	91·50	2802	217·6
	a	6.36.41·56	−15.53.41·4	7	310·21	3680	286·4
Sirius - -		39.56·81	−16.33.20·8	−1·4			
	β	42.22·37	−17.22.49·8	7	144·90	3630	282·0
	a	34.49·95	−17.11.12·3	7¾	242·77	4950	385·3
	b	6.45. 5·45	−15.53.40·0	8	61·83	5030	391·9
	a	21.49.56·38	−57.15.56·0	7¼	270·35	2130	165·8
ε Indi - -		21.54.19·39	−57.16.10·6	5·2			
	β	21.59.38·30	−57.25.28·5	7¾	102·17	2640	205·2
	a	21.44.30·89	−57.53.14·0	7	244·83	5200	406·4
	b	22. 5. 2·96	−57.53. 7·3	7¼	63·10	5920	459·5
	α	22.49.34·82	−37.18.25·9	7·9	245·88	6830	531·0
Lacaille 9352		22.58.14·42	−36.31.55·8	7·5			
	β	23. 3.47·98	−36. 2.17·8	7·3	66·21	4410	342·5
	a	4. 5. 6·75	− 9. 7.42·0	6·0	220·17	6270	487·3
o_2 Eridani -		9.50·48	− 7.50.15·0	4·4			
	β	4.14.51·47	− 6.31.38·8	6·7	43·52	6500	505·2
	γ	13.53.37·90	−59.41. 5·2	7	296·26	950	73·9
β Centauri -		13.55.30·40	−59.48. 9·6	1·2			
	a	0.12.43·63	−64. 7.52·8	7⅛	355·02	5190	403·7
ζ Tucanæ -		13.54·74	−65.34. 6·0	4·1			
	b	0.16. 0·10	−66.57.31·9	7⅛	171·42	5060	393·5
	a	3. 8.17·08	−44.51.45·9	6·2	221·93	6570	511·4
e Eridani -		15.12·89	−43.31.18·9	4·4			
	b	3.21.58·74	−42.·3. 4·1	6·5	42·54	6920	538·3
	a	6.18.48·41	−52.36.16·0	8	293·98	1380	107·6
Canopus -		21.19·92	−52.37.53·8	0·4			
	b	6.23.29·71	−52.34.58·6	8½	81·50	1190	92·8

A complete observation consists of the following processes :—

1. The Position Circle is set to the required position-angle and the segments separated in distance the requisite amount.
2. The axis of the tube is directed, by means of the Hour and Declination Circles, to the middle point between the stars to be observed, when the images of the two stars are seen together in the field of view.
3. The observer, by slow motion in position-angle and distance, now brings the images to near contact, especially adjusting the distance as nearly as possible. This latter adjustment cannot be accurately made by superposing the images; the best practical method is to first place the images of the two stars so that, while the discs are nearly in contact, the line joining their centres shall be at right angles to the direction of measurement. The estimation of this condition is facilitated in two ways: 1st, the images formed by semi-lenses are not circles but ellipses, and when the definition is good and the stars are sufficiently bright, the most accurate plan is to make the major axes of the two ellipses coincident. The accuracy of this estimation is greatly enhanced by immediate and frequent interchange of the two images by use of the slow motion in position-angle. The symmetrical emergence of the elliptical discs from behind each other in alternate opposite directions forms the most refined method of "pointing" known to astronomers. When the images are very faint or ill-defined, the power of estimating distances in this way is not available, because the major axis of the ellipse cannot be precisely distinguished. To provide for this, four flat intersecting wires were inserted, in the common focus of the object glass and eye-piece, forming a square, in the centre of the field, two sides of the square are parallel to the direction of motion in distance, and two at right angles to this direction. The observer takes the latter pair of wires as his guides, and by motion of the "distance-handle" adjusts the position angle of the artificial close double star parallel to the direction of these wires. This observation is analogous to that in which an observer with a parallel-wire micrometer adjusts the wires parallel to the line joining the centres of the double star whose position angle he is measuring, but with this difference, that the latter moves the position-angle of his micrometer till the