Table III.

Observations of the Moon, 1862 to 1885.

Mean Errors of Longitude. Uncorrected and Corrected for Error in Mean Time.

Year.		Errors of Longitude. (Hansen – Observed.) *Uncorrected.*	*Corrected.*	Year.		Errors of Longitude. (Hansen – Observed.) *Uncorrected.*	*Corrected.*
		″	″			″	″
1862	Greenwich	−2·829	−2·829	1874	Greenwich	+ 9·294	+0·561
1863	„	−1·606	−1·606	1875	„	+ 9·867	+0·365
1864	„	+0·121	−0·814*	1876	„	+ 9·800	−0·509
1865	„	+1·271	−0·220	1877	„	+ 9·234	−1·898
1866	„	+2·142	−0·217	1878	„	+ 8·219	−3·603
1867	„	+3·480	+0·357	1879	„	+ 9·631	−3·124
1868	„	+4·117	+0·280	1880	„	+10·265	−3·245
1869	„	+4·277	−0·352	1881	„	+10·622	−3·791
1870	„	+4·828	−0·657	1882	Radcliffe	+12·927	−2·508
1871	„	+6·955	+0·435	1883	„	+14·615	−1·547
1872	„	+7·309	+0·097	1884	„	+14·645	−1·907
1873	„	+8·239	+0·200	1885	„	+15·144	−1·873

Radcliffe Observatory, Oxford,
1886, *January* 6.

On Photographs of a new Nebula in the Pleiades, and of Saturn.

(*Letter to the President, from MM. Paul and Prosper Henry.*)

Nous avons reconnu à l'aide de la photographie, l'existence d'une nébuleuse nouvelle dans les *Pléïades.* Cette nébuleuse est voisine de l'étoile Maïa, qu'elle contourne, en partie, et d'où elle paraît s'échapper.

Elle affecte une forme spirale bien caractérisée et son étendue est de 2′ ou 3′ environ.

Il nous a été possible d'obtenir l'image de la nébuleuse sur 3 épreuves différentes: le 16 Novembre et les 8 et 9 Décembre derniers.

Nous ajouterons que, jusqu'à présent, nous n'avons pu l'apercevoir dans nos télescopes.

Nous avons l'honneur de vous adresser, Monsieur le Président, une reproduction agrandie, du négatif original, montrant la nébuleuse avec les étoiles environnantes.

Nous nous sommes permis d'y joindre quelques images de *Saturne* obtenues dernièrement.

Observatoire de Paris,
le 5 *Janvier*, 1886.

* Here change in the unit of time took place.

Photographic Maps of the Stars. By Isaac Roberts.

The letter from Admiral Mouchez, which was published in the *Monthly Notices* for November, shows the necessity for making known what has already been done in the direction he indicates.

In the year 1883 I made experiments on photographing stars with ordinary portrait lenses varying in aperture between three-eighths of an inch and five inches. The lenses were made by English, American, and French opticians. One of two inches aperture, by Lerebours et Secretan, gave the best results, and I adopted it as a standard for comparing the others. The comparisons were made by attaching two cameras to the declination axis of my 7-inch equatorially mounted Refractor, by Cooke, and taking simultaneous photographs of some well-known group of stars under precisely similar conditions.

The photographic plates were selected with regard to uniformity, and sometimes a plate would be cut in two, one-half being exposed in each camera under similar conditions.*

The result of these experiments and comparison with Mr. Common's great photograph of the nebula in *Orion* was that I gave Mr. Howard Grubb an order to make me a 20-inch silver-on-glass reflector with 100 inches focal length; the photographs to be taken directly in the focus of the mirror, to obviate any loss of light by a second reflection. The photographic telescope to be mounted on the same declination axis as the 7-inch Refractor, one being the counterpoise to the other.

Both telescopes move independently in Declination, but the motion in Right Ascension is common to both.†

The duplex telescope was mounted in March 1885, and after determining the size of the photo-field, the amount of overlap required, the time of exposure and preparing a method for easily registering the negatives, I was ready on May 1 to commence the regular work of taking photographs of the stars in the northern hemisphere, commencing at the Pole.

The size of the field which I adopted is 2° in Declination, and about $1\frac{1}{2}$° in Right Ascension, thus allowing sufficient margin for overlap. The time of exposure is fifteen minutes of clear sky, the photo-field being on or near the Meridian, and an allowance in time made for any mistiness or clouds which may arise when taking a photograph.

* On some recent experience in photographing stars with ordinary cameras and lenses by the author. *Proceedings* of the Liverpool Astronomical Society, vol. ii. p. 41.

† To Dr. Huggins is due the credit for devising this most ingenious, simple, and useful mode of mounting a reflector and refractor side by side; and the skill of Mr. Howard Grubb is well shown in the arrangements of the instrument to perform well the objects intended.

The frequent atmospheric changes that occur in our climate are important elements to be considered in fixing the time for exposing the photographs, and under this head the suggestion of Admiral Mouchez, for an exposure of one to three hours, if adopted, would make the progress of the work extremely slow.

Fifteen minutes of clear sky can often be utilised by keeping a good look-out, but an hour or three hours are rarely available.

Stars of small magnitude can be photographed by my reflector in fifteen minutes, but it would be misleading to name the photographic magnitudes by those which have been determined by eye-observations until comparisons have been made between large numbers of stars and the errors consequent upon the focussing of the instrument, the varying sensitiveness of the plates, the duration of the exposure, the varying actinism caused by moisture in the atmosphere, the varying density of image obtained in developing, &c., have been eliminated or reduced to a constant factor.

At present I will only refer to the experimental plates on which *Polaris* has been photographed when near the upper Meridian. Between September 15 and December 15, 1885, seventeen photographs have been taken with exposure of each plate between *one second* and *thirty-two minutes*. On some of them the *companion* is photographed faintly in *four seconds*, whilst on others it does not appear under an exposure of *one minute*, and on one plate it does not appear on exposure up to *sixteen minutes*' duration. I must defer the discussion of this subject to another occasion; but it is evident that the interpretation of photographs, as regards star colour and magnitude, should be done under due sense of the difficulties here named.

The diagram shows the form of record which I keep of the photographs.

The upper numerals in each space correspond with those marked on the film. The lower numerals are the Right Ascensions, and the degrees (84° to 90°) are the Declinations at the middle of each plate. A cross is marked upon each space after the photograph is taken and examined, and if more than one is taken of any space, a dot is inserted to record each additional photograph.

The Polar plate is a circle 2° in diameter; then concentrically with it are zones 2° in Declination, and of the widths respectively shown in Right Ascension, which, together with the convergence of the Meridians, give a large overlap for tracing stars on contiguous plates.

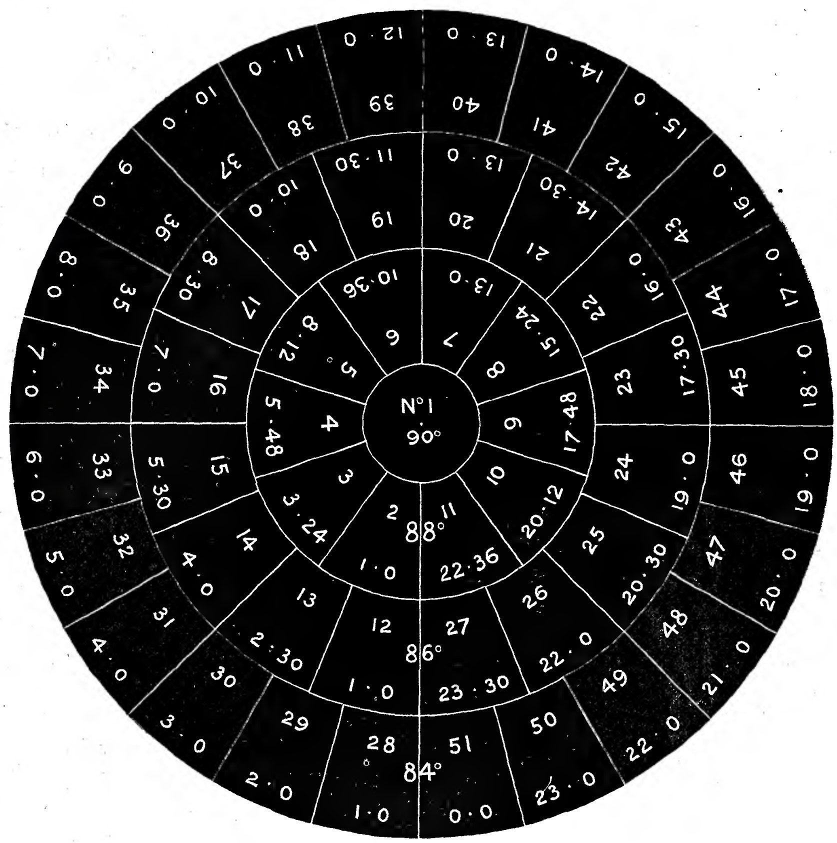
Each plate is marked on the film with the hour it was taken, the day, the month, the year, and the number, corresponding with that on the index chart. A book is also kept with these particulars in vertical columns, and remarks upon the state of the sky are recorded.

The following is a list of the photographs which have been taken up to December 29, 1885:—

Dec. 90° = polar circle.

Dec.		R.A.	
87° to 89°	— R.A.	1h 0m to 9h 24m	and 11h 48m to 24h 0m
„ 85 „ 87	— „	1 0 „ 24 0 = the zone complete.	
„ 83 „ 85	— „	1 30 „ 8 30	and 15h 30m to 24h 0m
„ 81 „ 83	— „	1 0 „ 6 37	„ 15 37 to 24 0
„ 79 „ 81	— „	1 0 „ 7 18	„ 17 0 to 24 0
„ 77 „ 79	— „	1 0 „ 7 56	„ 18 0 to 24 0
„ 75 „ 77	— „	1 0 „ 7 15	„ 20 15 to 24 0
„ 73 „ 75	— „	2 18 „ 9 12	„ 20 24 to 24 0
„ 71 „ 73	— „	2 50 „ 6 50	
„ 69 „ 71	— „	4 24 „ 5 21	

The negatives are stored in grooved wood boxes, each forming a sliding drawer, and containing 100 plates.



Part of chart for registration of star photographs.

The register number on the chart, in the book, and on the box refer to the number marked on the film of the negative.

How the negatives are to be reduced, and the information which they contain is to be utilised astronomically, are questions which are constantly present with me, and the difficulties in answering them cannot be fully realised but by those who have seriously tried, and I may here enumerate some of them.

Most of the photographic plates have small specks in the film, many of which look like stars, and are difficult to distinguish from stars even when viewed through a microscope. Dr. Gill, at the Cape Observatory, meets the difficulty by taking two photographs successively of the same field, giving to each an exposure of one hour; but this makes the work almost Herculean, especially where clouds generally cover the sky. Another plan is to let the telescope run a few seconds of arc in Right Ascension during the exposure of the plate. This, again, is equivalent to two or more exposures of the stars upon different points of the film, and make what would be called one hour's exposure in reality only an exposure of some fraction of an hour. Admiral Mouchez suggests three exposures of an hour each, thus making a triangular figure with three positions of the same star. The objections to this are—great loss of time, confusion in positions of close stars, causing the discs of some to overlap others, and leaving the dirt specks still competing for recognition as stars.

Long exposures of the plates add to the difficulty in discriminating between specks and stars, by making the star discs appear large and black to the margins; but with a short exposure the small star discs show fainter, and often the atmospheric glare forms a halo round the star, which under the microscope materially assists in distinguishing between stars and specks.

All stars below, say, the 7th magnitude, require the aid of a lens or microscope to see them, but I do not find great difficulty in manipulating the light, the plate, and the microscope in such a way that the stars can with considerable certainty be distinguished from specks on the photographs taken with the 20-inch Reflector and exposure of fifteen minutes.

These statements refer only to viewing the stars by the aid of a microscope, and do not apply to printing them direct from the negatives, which in some form must be done before star photography can be appreciated and generally utilised as an astronomical pursuit. This is an additional problem, to those already referred to, that yet has to be solved.

The work of first importance is to secure good photographs of all stars down to the smallest magnitude practicable in as short a time as possible. They will in all future time be available for comparison with photographs which can at leisure be taken by large instruments for special researches.

The chart upon which I am engaged will be upon a scale twice the size of *Argelander's*, and, with an exposure of fifteen minutes for each plate, will contain a much larger number of stars than are shown on the *Atlas des Nördlichen Gestirnten Himmels.*

I submit a few negatives as samples of the general character of those already taken. Amongst them are plates of *Polaris*—*Andromeda* with the *Nova*—the *Pleiades* and *Nebula* in *Orion*.

On the Orbit of γ Coronæ Australis. By J. E. Gore.

The duplicity of this interesting binary star was discovered by Sir John Herschel at the Cape of Good Hope. Elements of the orbit were published by Captain Jacob in the year 1855 (*Monthly Notices*, R.A.S., vol. xv. p. 208), and he found a period of 100·80 years, with periastron passage, 1863·08. Some years since Prof. Schiaparelli published elements in No. 2,073 of the *Astronomische Nachrichten*, in which he assigns a period of 55·582 years, with an eccentricity of 0·6989, and periastron passage 1882·774. These elements were corrected by Mr. Downing (*Monthly Notices*, May 1883). As there are considerable differences between the elements found by Captain Jacob and Prof. Schiaparelli, particularly in the length of the period, I determined to make a new computation of the elements, and details of the results I have arrived at may be of interest.

The orbit was computed by a graphical method, in which the dimensions and position of the real ellipse are derived from those of the apparent ellipse by means of Thiele's harmonic ellipse. This latter ellipse being the orthogonal projection of the harmonic circle on a plane perpendicular to the line of sight, its major axis is of course equal in magnitude to the *latus rectum* of the real ellipse, and its angle of eccentricity is the angle of inclination of the plane of the real ellipse to the plane of projection on the background of the heavens. Thus the magnitude and position of the real orbit can be fully determined.

The following are the observations from which I have computed the elements. They have been corrected for precession, by the usual formula, to the epoch 1880·0:—

γ Coronæ Australis.

Angles and Distances: Angles reduced to 1880.

R.A. 1880, $18^h\ 59^m = 284°\ 45'$.

Dec. S. 37° 18′.

Correction $= 0°·0055 \sin \alpha \sec \delta = -0°·007$ per annum.

t	θ'	θ	r	Observer.
	°	°	″	
1834·47	37·1	36·78	2·66	Sir John Herschel.
1835·55	36·8	36·5	2·66	„ „
1836·43	34·5	34·2	2·66	„ „
1837·43	32·7	32·4	2·66	„ „
1858·203	343·42	343·27	1·53	Jacob.
1863·836	318·1	318·0	1·25	Powell.
1875·65	257·4	257·37	1·45	Schiaparelli.