MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XXVII. *February* 8, 1867. No. 4.

THE Annual General Meeting of the Society:

Rev. CHARLES PRITCHARD, President, in the Chair.

Francis Cranmer Penrose, Esq., Wimbledon;
John Morgan, Esq., Glasgow;
Francis Bowen, Esq., Trinity College, Cambridge; and
James Carpenter, Esq., Royal Observatory, Greenwich,

were balloted for and duly elected Fellows of the Society.

Report of the Council to the Forty-seventh Annual General Meeting of the Society.

Progress and present state of the Society:—

	Compounders.	Annual Contributors.	Non-residents.	Patronesses, and Honorary.	Total Fellows.	Associates.	Grand Total.
December 31, 1865	167	272	22	4	465	46	511
Since elected ...	12	23	...	...	...	4	...
Deceased	−7	−5	−8	...	...	−3	...
Name withdrawn	...	−1	...	...	...	...	...
Expelled	...	−7	...	...	...	...	...
Resigned	...	−3	...	...	...	...	...
Removals	+1	−1	...	...	...	...	...
Dec. 31, 1866 ...	173	278	14	4	469	47	516

Mr. Whitbread's Account as Treasurer of the Royal Astronomical Society, from January 1 to December 31, 1866:—

RECEIPTS.

	£	s.	d.	£	s.	d.
Balance of last year's account				307	17	2
By Dividend on £2300 Consols	33	18	6			
By ditto on £5000 New 3 per Cents	73	15	0			
By ditto on £2600 Consols ...	38	7	0			
By ditto on £5000 New 3 per Cents	73	15	0			
				219	15	6
On account of arrears of contributions ...	144	18	0			
129 annual contributions	271	19	0			
34 admission-fees	71	8	0			
23 first contributions	42	0	0			
	530	5	0			
12 compositions	249	18	0			
				780	3	0
Sale of publications				72	0	0
				£1379	15	8

EXPENDITURE.

	£	s.	d.	£	s.	d.
alaries :—						
Editor of Publications	60	0	0			
Assistant Secretary	100	0	0			
Commission on Collecting	30	2	0			
				190	2	0
Taxes :—						
Land and Assessed	6	11	0			
Income	1	13	4			
Poor Rate	8	2	6			
Other Parish Rates	9	11	8			
				25	18	6
Repairs:—						
Beard and Morrison, painters ...	43	9	4			
Bunnington, carpenter	13	14	0			
Taylor, floorcloth, &c.	7	16	0			
				64	19	4
Bills : —						
Strangeways and Co., printers ...	219	11	10			
Rumfitt, bookbinder	13	19	4			
Basire, engraver	39	12	6			
Pearson, wood-engraver	2	10	0			
Roberson, cleaning paintings	4	15	0			
Cooke and Sons, Equatoreal Stand ...	55	17	6			
Annual Dinner (deficiency)	11	11	6			
Insurance	10	0	6			
				357	18	2
Miscellaneous items :—						
Reduction of Sir W. Herschel's observations	50	0	0			
Books and parcels	5	10	7			
Postages	41	5	1			
House expenses	27	8	6			
Expenses of evening meetings ...	13	13	0			
Waiters attending meetings	3	17	0			
Coals and wood	12	0	0			
Gas	8	0	4			
Repairs	2	14	6			
Sundries	18	19	5			
				183	8	5
				822	6	5
Lee Fund	6	0	0			
Turnor Fund	5	7	8			
Mrs. Jackson's annuity, 1 year ...	8	17	0			
				20	4	8
Total payments				842	11	1
Investments :—						
Purchase of £300 Consols, $87\frac{1}{8}$ ...	261	15	0			
Ditto 200 $89\frac{3}{4}$ ...	179	15	0			
				441	10	0
Balance at Banker's	98	4	7			
Less Pearson's cheque unpaid ...	2	10	0			
				95	14	7
				£1379	15	8

Audited and found correct, this twenty-ninth day of January, eighteen hundred and sixty-seven,

H. Perigal, jun., *Auditor.*

Assets and Present Property of the Society, January 1, 1867:—

	£ s. d.	£ s. d.
Balance at Banker's		95 14 7
2 Contributions of 5 years' standing ...	21 0 0	
1 ,, 4 ,, ...	8 8 0	
21 ,, 3 ,, ..	132 6 0	
27 ,, 2 ,, ...	113 8 0	
74 ,, 1 ,, ...	155 8 0	
1 admission-fee, &c., and subscription for 1866	5 5 0	
		435 15 0
Due for Publications		2 10 6
£5000 New 3 Per Cents (including Mrs. Jackson's Gift, £300).		
£2800 Consols, including the Lee Fund (£100) and Turnor Fund (£500).		
Unsold Publications of the Society.		
Various astronomical instruments, books, prints, &c.		
Balance of Turnor Fund (included in Treasurer's Account)		101 3 9

Stock of volumes of the *Memoirs*:—

Vol.	Total.	Vol.	Total.	Vol.	Total.
I. Part 1	15	XI.	191	XXII.	187
I. Part 2	56	XII.	198	XXIII.	187
II. Part 1	73	XIII.	211	XXIV.	193
II. Part 2	37	XIV.	400	XXV.	203
III. Part 1	90	XV.	179	XXVI.	211
III. Part 2	100	XVI.	204	XXVII.	470
IV. Part 1	109	XVII.	201	XXVIII.	427
IV. Part 2	121	XVIII.	183	XXIX.	454
V.	135	XIX.	194	XXX.	208
VI.	156	XX.	185	XXXI.	188
VII.	179	XXI. Part 1	316	XXXII.	219
VIII.	165	XXI. Part 2	100	XXXIII.	235
IX.	169	XXI. (together).	97	XXXIV.	250
X.	181				

The instruments belonging to the Society are as follows:—

The *Harrison* clock,
The *Owen* portable circle,
The *Beaufoy* circle,
The *Beaufoy* transit,
The *Herschelian* 7-foot telescope,
The *Greig* universal instrument,
The *Smeaton* equatoreal,
The *Cavendish* apparatus,
The 7-foot Gregorian telescope (late Mr. Shearman's),
The Variation transit (late Mr. Shearman's),
The Universal quadrant by Abraham Sharp,
The *Fuller* theodolite,
The Standard scale,
The *Beaufoy* clock, No. 1,
The *Beaufoy* clock, No. 2,
The *Wollaston* telescope,
The *Lee* circle,
The *Sharpe* reflecting circle,
The *Brisbane* circle.

The *Sheepshanks'* collection of instruments, viz.,—

1. 30-inch transit, by Simms, with level and two iron stands.

2. 6-inch transit theodolite, with circles divided on silver; reading microscopes, both for altitude and azimuth; cross and siding levels; magnetic needle; plumbline; portable clamping foot and tripod stand.

3. $4\frac{6}{10}$ achromatic telescope, about 5 feet 6 inches focal length; finder, rack motion; double-image micrometer; object-glass micrometer; two other micrometers; one terrestrial and ten astronomical eyepieces, applied by means of two adapters.

4. $3\frac{1}{4}$-inch achromatic telescope, with equatoreal stand; double-image micrometer; one terrestrial and three astronomical eyepieces.

5. $2\frac{3}{4}$-inch achromatic telescope, with stand; one terrestrial and three astronomical eyepieces.

6. $2\frac{3}{4}$ achromatic telescope, about 30 inches focus; one terrestrial and four astronomical eyepieces.

7. 2-foot navy telescope.

8. 45-inch transit instrument, with iron stand, and also Y's for fixing to stone piers; two axis levels.

9. Repeating theodolite, by Ertel, with folding tripod stand.

10. 8-inch pillar-sextant, divided on platinum, with counterpoise stand and horizon roof.

11. Portable zenith instrument, with detached micrometer and eyepiece.

12. 18-inch Borda's repeating circle, by Troughton.

13. 8-inch vertical repeating circle, with diagonal telescope, by Troughton and Simms.
14. A set of surveying instruments, consisting of a 12-inch theodolite for horizontal angles only, with extra pair of parallel plates; tripod staff; in which the telescope tube is packed; repeating table; level collimator, with micrometer eyepiece; and Troughton's levelling staff.
15. Level collimator, plain diaphragm.
16. 10-inch reflecting circle, by Troughton, with counter-poise stand; artificial horizon, with metallic roof; two tripod stands, one with table for artificial horizon.
17. Hassler's reflecting circle, by Troughton, with counter-poise stand.
18. 6-inch reflecting circle, by Troughton, with two counterpoise stands, one with artificial horizon.
19. 5-inch reflecting circle, by Lenoir.
20. Reflecting circle, by Jecker, of Paris.
21. Box sextant and 3-inch plane artificial horizon.
22. Prismatic compass.
23. Mountain barometer.
24. Prismatic compass.
25. 5-inch compass.
26. Dipping needle.
27. Intensity needle.
28. Ditto ditto.
29. Box of magnetic apparatus.
30. Hassler's reflecting circle, with artificial horizon roof.
31. Box sextant and $2\frac{1}{4}$-inch glass plane artificial horizon.
32. Plane speculum artificial horizon and stand.
33. $2\frac{1}{2}$-inch circular level horizon, by Dollond.
34. Artificial horizon roof and trough.
35. Set of drawing instruments, consisting of 6-inch circular protractor; common ditto; 2-foot plotting scale; two beam compasses and small T square.
36. A pentagraph.
37. A noddy.
38. A small Galilean telescope, with the object lens of rock-crystal.
39. Six levels, various.
40. 18-inch celestial globe.
41. Varley stand for telescope.
42. Thermometer.
43. Telescope, with the object-glass of rock crystal.

These are now in the apartments of the Society, with the exception of the following, which are lent, during the pleasure of the Council, to the several parties under mentioned, viz.:—

The *Fuller* theodolite, to the Director of the Sydney Observatory.

The *Beaufoy* transit, to the Observatory, Kingston, Canada.

The *Sheepshanks* instrument,		No. 1, to Mr. Lassell.
Ditto	ditto	No. 2, to Mr. De La Rue.
Ditto	ditto	No. 4, to Rev. C. Lowndes.
Ditto	ditto	No. 5, to Mr. Birt.
Ditto	ditto	No. 6, to Rev. J. Cape.
Ditto	ditto	No. 8, to Rev. C. Pritchard.
Ditto	ditto	No. 9, to the Director of the Sydney Observatory.
Ditto	ditto	No. 10, to Admiral Bethune.
Ditto	ditto	No. 19, to Capt. John Jones.
Ditto	ditto	No. 41, to Rev. C. Pritchard.
Ditto	ditto	No. 43, to Mr. Huggins.

The 6-inch circular protractor, to Mr. Birt.

The Volume of the Memoirs

will contain:—

I. "Mean North Polar Distances of *Rigel*, *α Orionis*, *Sirius*, *and α Hydræ*, for Jan. 1 of each Year, derived from Observations with the Transit Circle, made at the Royal Observatory, Cape of Good Hope, in the Years 1856–63." By Sir Thomas Maclear, Director of the Royal Observatory, Cape of Good Hope.

II. "Geocentric Right Ascensions and North Polar Distances of Encke's Comet, derived from Observations made at the Royal Observatory, Cape of Good Hope." By Sir Thomas Maclear, Director of the Royal Observatory, Cape of Good Hope.

III. "A Synopsis of all Sir William Herschel's Micrometrical Measurements, and Estimated Positions and Distances of the Double Stars described by him, together with a Catalogue of those Stars in order of Right Ascension for the epoch 1880·0, as far as they are capable of identification." By Sir J. F. W. Herschel, Bart.

IV. "Catalogue of Micrometrical Measurements of Double Stars, comprising all the Measures obtained by him between the close of his Second Series (published in the *R. A. S. Memoirs*, vol. xix.) and the present time." By the Rev. W. R. Dawes.

The former and principal part of the Series contains Observations made to the end of the year 1854: to which is added an Appendix containing such as have been subsequently effected. The Catalogue itself is preceded by a description of the different Micrometers employed.

V. "A Series of Observations at Malta with the Four-foot Equatoreal, comprising Observations of *Neptune* and his Satellites; Observations of the Satellites of *Saturn;* Observations of *Uranus* and his Satellites; Observations and Drawings of known Nebulæ; Cursory Observations of various Objects not Classified; and a Catalogue of New Nebulæ." By Mr. Lassell.

Obituary.

The Society has to regret the loss of the following Fellows and Associates :—

Fellows.— Dr. Anderson.
W. Bowers, Esq.
J. Breen, Esq.
J. Burman, Esq.
W. Coffin, Esq.
G. Dollond, Esq.
Col. Sir George Everest.
Walter Ewer, Esq.
W. Gravatt, Esq.
W. D. Haggard, Esq.
Rev. J. Hind (prematurely reported last year).
R. H. Kennedy, Esq.
Dr. Lee.
Capt. Norquoy.
Admiral Owen.
Capt. Ronald.
G. T. Sadler, Esq.
Capt. H. Scott.
Lieut.-Col. P. Stewart.
G. Webbe, Esq.
Dr. Whewell.

Associates.— M. H. Goldschmidt.
M. Hencke.

James Breen was born at Armagh, Ireland, July 5, 1826. He was the second son of the late Mr. Hugh Breen, Sen., who superintended the Lunar Reductions at the Royal Observatory, Greenwich. He was educated at the Grammar-school (attached to the Cathedral) of his native town, then under the direction of the Rev. James Groves, M.A, of Trinity College, Dublin. In the August of 1840 he was engaged at the Royal Observatory as a calculator, and continued there till August 1846, when he was appointed at the Cambridge Observatory, where he remained zealously occupied as an astronomical observer until his resignation at the end of the year 1858. During this period he published a book, *The Planetary Worlds.* After leaving Cambridge Mr. Breen went to Paris, where he resided a considerable time, frequenting the lecture-rooms of the University, and studying French literature. Here he was introduced, amongst others, to M. Goldschmidt, who afterwards kept up a correspondence with him. In the midsummer of 1860 he proceeded from Paris into Spain, where, at Camuesa, in conjunction with Mr. Buckingham and Mr. Wray, of the Himalaya Expedition, he observed the great solar eclipse of July 18. After some stay in Switzerland he returned to London in 1861, and devoted himself entirely to literary pursuits, spending much of his time in the Reading Room of the British Museum, enlarging his already considerable knowledge of English, French, and German literature, and cultivating an acquaintance with other languages. He was a contributor from the first to the *Popular Science Review*, and supplied articles to other portions of the press, but mostly anonymously. He had written a greater portion of a book on the Stars, Clusters, and Nebulæ: Mr. Hardwicke, of Piccadilly, having undertaken its publication, two sheets were already printed, when the ravages of consumption, which had been long undermining his constitution, rendered further work impossible. Conscious to the last, and prepared for the death which he knew to be inevitable, he expired tranquilly at noon, on August 25, 1866, and was buried on the following Wednesday in his father's grave at Nunhead Cemetery.

The late Sir GEORGE EVEREST was a son of Tristram Everest, Esq., of Gwernvale, Brecon, where he was born on the 4th July, 1790. He early showed signs of his future eminence, having qualified himself at Woolwich for a commission before the age at which the law admitted of his holding a commission, and he was especially noted by Dr. Hutton (then Professor of Mathematics), who, in a letter to his father, predicted his arriving at distinction. Everest sailed for India as a Cadet, to join the Bengal Artillery in 1806; and after seven years of military duty, was sent to join a detachment of his regiment in Java. Here he attracted the attention of Sir Stamford Raffles, then British Governor of that island, who selected him to make a survey of it; on which he was occupied from 1814 to 1816. On Sir George's return to India he was employed in improving the navigation of some of the numerous streams into which the Ganges divides itself before entering the sea, and afterwards in establishing telegraphic communication between Calcutta and the Upper Provinces.

On the completion of this last duty he was permitted to join Colonel Lambton, the original Superintendent of the Trigonometrical Survey of India, whose Chief Assistant he had some time before been appointed; and he entered on the labours which will ever connect his name with researches on the Earth's figure. Employment in an unhealthy part of the country drove him to seek health at the Cape of Good Hope, where his leisure was employed in criticising the Arc of the Meridian measured in that colony by the Abbé de La Caille. The result of his investigations was embodied in a letter to Lieutenant-Colonel Lambton, which appeared in the first volume of our *Memoirs*, and which eventually led to the revision and extension of the Arc by Sir Thomas Maclear and his assistants, in the course of which the criticism was mainly justified. Not long after his return to India in 1823, Everest succeeded, at Colonel Lambton's death, to the superintendence of the Trigonometrical Survey. His attention was at once devoted to the Great Indian Arc of the Meridian, which he completed to latitude 24° 7′, when he was again compelled to resort to a better climate to recruit his health. While in England, on this occasion, he was enabled, by the liberality of the Honourable Court of Directors of the East India Company, to publish an abstract of his labours, which bears the date of 1830. In that year, too, Sir George Everest returned to India, having made himself acquainted with the instruments and processes in use in the Ordnance Survey, and taking with him a set of Colonel Colby's compensated bars for base-line measurement, new standard bars, and a 34-inch theodolite, as well as two vertical circles, especially intended for use in the observation of differences of latitude. All of these, as well as a number of smaller instruments for his department, were furnished by the late Edward Troughton.

From this time the operations of the Indian Survey became of an accuracy which has not been exceeded anywhere. The opaque signals previously employed were replaced by Heliostats in the day, and Argand lamps at nights; and it thus became possible to pierce the dense atmosphere of India in the dry season, and avoid the comparatively unhealthy rains. In crossing the plains of Upper India, it became necessary to elevate these signals and the instruments and observers to a considerable height on masonry towers, both to overcome the curvature of the Earth, and to avoid the dense and irregularly refracting strata of the atmosphere at the surface of the heated Earth. The new material rendered a new training necessary for the subordinate members of the department; and at the time this was being imparted, Colonel Everest's labours were increased by his appointment as Surveyor-General of India, and the abolition, very shortly afterwards, of the offices of Deputy Surveyor-Generals at Madras and Bombay. It was the end of 1832 before all the delays consequent on these matters were over, and the new apparatus and system had been tried in measuring a base line near Calcutta. Then, after a suspension of seven years, the measurement of the Meridional Arc was resumed, and its extension to the Himalayas was the first result. The experience gained here showed that the new arrangements had introduced an accuracy previously unattainable, and Colonel Everest proceeded, with the sanction of the Court of Directors, to revise that portion of the Meridional Arc which had been measured by him previously to 1830, between the latitudes of 18° 3′ and 24° 7′, and which he now made of the same accuracy as the northern portion. The whole of these operations were completed in 1841 by the measurement near Bedor of a base-line under the immediate superintendence of Colonel Everest's chief assistant (now Sir Andrew Scott Waugh). The methods employed, and the results attained, are so fully detailed in a work published in 1847, by order of the Court of Directors of the East India Company, that it would be superfluous to enter on them here. The labours, of which that work is the record, were recognised by the award, in 1848, to its author by this Society of a Testimonial, to be considered as equivalent to a Medal, an honour which was shared with Colonel Everest by some of the most eminent of our Fellows. Sir George Everest's last publication on this subject was a letter to Professor Stokes in 1859, in which he made known some corrections to the numerical results contained in his book of 1847, arising from errors in the Logarithmic Tables employed, but he sat on the Council of the Royal Geographical Society up to his death, and at one time on that of the Royal Society.

Such, then, is a recapitulation of Sir George Everest's labours; but, in a case where services so eminent have been rendered to our especial science, we may be permitted to sketch slightly some of the points which distinguished our deceased fellow. Educated at a time when hardly any one in England was acquainted with the works of foreign mathematicians, and going at an early age to a distant land, Sir George Everest, in the intervals of a busy and practical life, nevertheless acquired a familiarity with the writings and methods of foreign geodesists, and appreciated them so much that he adopted their formulæ, verifying and extending them so as to prevent the accumulation of error in operations of an unprecedented magnitude, and he employed the acquired calculus in estimating, soon after assuming charge of the Survey, the attraction of the Mahadeo or Gawilgurh range of hills, on the station of Takalkhera, showing that the two arcs of which it was the common point were capable, by probable values for the masses of the attracting range, of being rendered accordant with the general figure of the Earth. Perhaps the greatest practical improvement he made was in the system of observing horizontal angles and azimuths. In 1808 the instrument he was to use (a theodolite, by Cary) was injured by an accident, which visibly distorted the limb. Colonel Lambton (the then Superintendent of the Survey) had by immense labour restored it to something like its original shape, and in some measure eliminated the remaining errors by changes of the initial reading or zero. Colonel Everest was led to adopt the plan of making this change by equal aliquot parts of the space between two micrometers. So satisfactory was the result that, when he acquired Troughton's beautiful instrument, he was induced to continue the practice. It is still in use with modifications which experience has led to in the number of zero changes, and it is peculiar, it is thought, to Sir George's old department.

In geodesical operations we cannot afford to consider the circle of an instrument as having constant errors of graduations, the jars and strains to which it is subject in travelling render them to some extent new at each station, and these circles are exposed, as none need or should be in a permanent observatory, to unequal heatings and currents of air. The mode of changing zero (as it is termed in India), introduced by our late Fellow, grappled successfully with these difficulties; and it is to his clear perception of the advantages he had gained by it that his successors owe that the angles of their triangles and their azimuths are determined in the field with an accuracy which (as they think) is not surpassed in the best works of fixed observatories. In apportioning the residual error among the angles of his triangles, Colonel Everest was one of the first (if not the first) to recognise the existence of equations of condition (to be fulfilled by the true angles) other than the old one which made the sum of the angles of a triangle$=180+$ the spherical excess.

Throughout his career as an astronomer and geodesist Sir George Everest was careful to cultivate in himself and impress on his subordinates habits of the most rigorous exactness. He never neglected any precaution, however slight, which might improve his work; and while sparing no pains in observation, repudiated with characteristic energy the sentiments of a foreign *savant*, who declared that the fancied perfection of the repeating circle removed the necessity for well-conditioned triangles. So scrupulous was Sir George, that he would have nothing to do with researches which he did not think admitted of the accuracy he cultivated, lest the assistants whom he had trained with so much care and labour might lose their aptitude for his objects.

Sir George Everest was a Companion of the Bath, a Fellow of the Royal Society and of the Royal Geographical Society as well as of this, and a Member of the Royal Asiatic Society, and an Honorary Member of the Asiatic Society of Bengal. J. F. T.

William Gravatt was the son of Colonel Gravatt, of the Royal Engineers, and was born about the year 1807. Destined originally for the profession of a civil engineer he received some instruction from his father, and went through a course of practical mechanics in the factory of Messrs. Bryan Donkin and Co. He was afterwards appointed assistant at the works of the Thames Tunnel, and subsequently associated with the younger Brunel for many years on the Great Western and Bristol and Exeter railways. He was especially interested in the construction and working of Scheutz's calculating machine; and he privately circulated a specimen of its work, in the shape of a set of barometric tables calculated and stereoglyphed by the machine made by Messrs. Donkin for the office of the

Registrar General. He was also the inventor of a level which is known as the "Dumpy Level." He was a full member of the Institution of Civil Engineers, a Fellow of the Royal Society, and a foreign member of the Royal Academy of Sweden. His death took place, under painful circumstances, on the 30th of May, 1866. A draught of medicine, containing morphia, intended to be given in two doses, was, by an unfortunate mistake, administered to him in one, and he never awoke from the sleep which ensued: the circumstances of his death demanding an inquest, a verdict equivalent to one of accidental death was delivered.

JOHN LEE was the eldest son of John Fiott, a merchant of London (a descendant of the old Burgundian house, Fiott of Dijon), by Harriett, daughter of William Lee, of Totteridge Park, Herts. He was born on the 28th of April, 1783, and entered St. John's College, Cambridge, where he graduated as fifth wrangler in 1806. The senior wrangler of the year being Lord Chief Baron Pollock, of the Exchequer. In due course he was elected to a Fellowship of his College, and having obtained a Travelling Scholarship, he availed himself of the opportunity to visit Greece, Egypt, and the Holy Land, and succeeded in amassing a very valuable collection of antiquities, which it was always the study of his after-life to increase. In 1815, he assumed the name of Lee, in lieu of his patronymic, by royal license, in compliance with the will of his maternal uncle, William Lee Antonie, of Colworth House, Beds. On the death of Sir George Lee, Bart., without issue, in 1827, the whole of the family property devolved upon Dr. Lee. Dr. Lee was a Fellow of the Royal, the Antiquarian, the Meteorlogical, and many other learned and scientific Societies. He was elected a Fellow of our Society in 1824. He was Treasurer of the Society from 1831 to 1840, and served the office of President in the years 1861 and 1862. The Society is indebted to him for the establishment of the Lee Fund for the relief of the widows and children of deceased Fellows, and for a valuable Astronomical Instrument, the Lee Circle.

In the year 1836 he presented to the Society the perpetual advowson of the living of Hartwell, and in the year 1844 he added to his former gift the vicarage of Stone, both valuable livings, now held by Fellows of the Society.

Dr. Lee was twice married, but had no issue. He died February 1866, at the age of eighty-three, and will be long lamented by his friends for his kind and amiable disposition, and by his tenantry and others to whom he had endeared himself by his uniform benevolence and attention to their wants and interests.

The most important astronomical work of Dr. Lee's life was the establishment, in 1831, of the Hartwell Observatory, which was provided with first-class instruments, and maintained for many years in a state of efficiency.

Many valuable observations were made there by the late lamented Admiral Smyth, and for several years Dr. Lee secured the services of Mr. Pogson. Mr. Pogson, whilst with Dr. Lee, was chiefly employed in continuance of his observations on Variable Stars. It was a matter of great regret to Dr. Lee that he could not see the publication of the "Variable Star Atlas," incorporating all these observations of Mr. Pogson,—a work which was interrupted by Mr. Pogson's appointment to the Directorship of the Madras Observatory.

With the exception of a few papers in the *Archæologia* and other scientific publications, Dr. Lee was not distinguished as an author; but the liberality with which he patronised objects in aid of public utility is fully exemplified in the following list of valuable works by the late Admiral W. H. Smyth, which were published at his sole expense:—

1. Descriptive Catalogue of a Cabinet of Roman Imperial large Brass Medals. 4to. Bedford, 1834.
2. Ædes Hartwellianæ: Notices of the Manor and Mansion of Hartwell. 4to. London, 1851. In this work will be found a description of the Observatory and Instruments, and Observations made there by Mr. James Epps and Admiral Smyth.
3. Addenda to Ædes Hartwellianæ. 4to. London, 1864.
4. The Cycle of Celestial Objects continued at the Hartwell Observatory to 1859. 4to. London, 1860. This work is commonly known as "Speculum Hartwellianum."

In the life of William Whewell, we have a striking example of the way in which in this country a man of real intellectual power, and determination of character, may break through the trammels imposed by humble birth; he was born on May 24, 1794, at Lancaster, where his father was a house-carpenter; his intellectual strength appears to have come from the mother's side. He was educated first at a grammar-school of his native place, and afterwards at Heversham, whither he removed in order to be qualified for holding an exhibition to Trinity College, Cambridge, connected with that school. Having gained this exhibition, then worth about 50*l.* a-year, he commenced residence at Trinity as a sub-sizar in October 1812. He soon became known in the College as the most promising man of his year. He was elected in due course to a foundation sizarship and to a scholarship. In his second year he gained the Chancellor's medal for the best English poem on the subject of "Boadicea." In the mathematical tripos of 1816, he graduated as second wrangler, the first place being gained by Jacob of Caius College. The Smith's Prize examination gave the same result. He was elected Fellow of Trinity in the following year, and soon afterwards commenced lecturing on mathematics as assistant tutor. His first book was *An Elementary Treatise on Mechanics*, vol. i. *containing Statics and part of Dynamics*. This work was published in

1819, but does not appear to have been followed by an *ostensible* vol. ii. It was a work of great value, strikingly logical and accurate. It is considered by one of our most eminent living mathematicians to have been very far in advance of any then existing text-book in the clearness and correctness of the treatment of bodies in contact and in the precision with which the assumptions involved in the laws of motion and the composition of forces are stated and illustrated. This work was followed by no less than twelve separate treatises on mechanics and Newton. Whewell was an advocate for the substitution of algebraical methods and modern calculus for the purely geometrical methods of former times, believing that it was only by these analytical methods that we could obtain solutions of our great physical problems, but he strongly insisted upon the necessity of studying the geometrical methods as an aid to a right understanding of our algebra. His view on this point is clearly expressed in the preface to his edition of *Newton's Three First Sections.* "It is very desirable that the mathematical student, before he rushes forward to differentiate and integrate upon the slightest provocation, should employ some thoughts in understanding the construction and trustworthiness of the instrument which he is so familiarly to use."

He was ordained soon after taking his M.A. degree. He became Tutor in 1823, and continued to discharge all the duties of the office alone till 1833, when he associated with himself Mr. Perry, the present Bishop of Melbourne. He remained tutor till 1839. During all this time he took a most active share in College and University business; serving with the greatest readiness on syndicates and committees.

In 1821 he was elected a Fellow of the Royal Society, which in 1837 accorded to him a Royal Medal for his investigations on the subject of the Tides.

His researches on the Tides undoubtedly constituted his principal direct contribution to the advancement of Science. He contributed no less than fourteen papers, and one supplementary paper, on this subject to the Royal Society. These papers will be found scattered through the *Philosophical Transactions* from 1833 to 1850. They are all of a similar character. Whewell attempted, from a discussion of Tidal Observations, to deduce empirically the laws of the tides at particular ports, and to trace any connexions which might exist between the constants which he thus obtained. He compared his results with Bernoulli's theory, and clearly pointed out those points which the theory could offer some explanation of, and those points which it could not touch. His great merit, in these researches, appears to have been the large and comprehensive views he took of the subject, and the energy with which he obtained the aid of and organised a body of observers for the contemporaneous observation of tidal phenomena all over the world.

It may be mentioned, to show that Whewell had a taste for practical science, although his path through life did not lead him in this direction, that he volunteered to and did assist the present Astronomer Royal in the pendulum experiments for the determination of the mean density of the Earth, made in a mine at Dolcoath, in Cornwall, in 1826 and 1828. These experiments both terminated in an unsatisfactory manner; the observers in 1826 had their instruments injured through a fire, and in 1828 the water broke into the mine, and thus put a stop to their operations.

In 1828, Whewell was made Professor of Mineralogy in the University of Cambridge. To prepare himself for this chair he went to Germany, and studied for some time under Professor Mohs. He also availed himself of his friendship with Professor Sedgwick to accompany him on his geological expeditions. In 1832 Whewell resigned this chair, and was succeeded by Dr. Miller.

He was one of the founders of the Cambridge Philosophical Society, and one of the most active promoters of the British Association.

In 1837 he published his *magnum opus*, the *History of the Inductive Sciences*. In the composition of this work he sought and received the most valuable assistance from a number of men eminent in their respective departments. For range of knowledge, for depth and grasp of thought, for lucidity of style, the *History* has few rivals in modern times. The *Philosophy of the Inductive Sciences* was published in 1841. This work was not so popular as its predecessor.

In 1838 he accepted the Professorship of Moral Philosophy, and henceforth he was to a great extent lost to physical science. In Moral Philosophy he was an ardent advocate for the rejection of Paley's basis of moral obligation, and substitution of that of moral sense; and he succeeded at last in expelling Paley's *Moral Philosophy* from the University. He wrote a valuable text-book on Moral Philosophy for the use of the University.

In October 1841 he succeeded Dr. Wordsworth in the Mastership of Trinity. And nobly did he uphold the pre-eminence of that College in the University.

He was twice married; first, in 1841, to Miss Cordelia Marshall; secondly, in 1858, to Lady Affleck, a sister of Robert Leslie Ellis. After his marriage with Lady Affleck, much of that ruggedness of manner which made him repellent to some passed away, and he became popular in that University where he had always been respected and admired. Lady Affleck died in 1865, deeply regretted by all who knew her. Whewell met with the accident that led to his death on February 24, and died on March 6, 1866.

His works are so numerous that it is almost impossible to collect a correct list of all of them. The principal of them are included in the annexed list, but this is, doubtless, far from complete. It would, however, be wrong to close this short notice of his life without specially mentioning his *Bridgewater Treatise*, one of the most popular books of modern times; his *Plurality of Worlds*, which perhaps, after all, however only proves how much may be said on a subject about which we know nothing; and his *Metaphysical Introductions* to the Encyclopedias. It may be mentioned, as a proof of the high position he had won in different branches of knowledge, that he was a correspondent of the French Academy, not in a mathematical section, but in a metaphysical section (Académie des Sciences Morales et Politiques, Section Philosophie). The extent of his knowledge was indeed wonderful, and generally accurate. Ancient History, Mediæval History, Botany, Geology, Mineralogy—all seemed to be alike to him. His *Architectural Notes on the German Churches, and Notes written during an Architectural Tour in Picardy and Normandy*, is still a standard book on ecclesiastical architecture.

The very universality of his knowledge has perhaps induced some to doubt his soundness; but this opinion, we believe, will not be justified by an examination of his works. He may not have been the first man of his age in any one branch of science, but he was in the foremost rank of many; and all he wrote is stamped with the logical clearness and precision of his own mind.

Whewell's works:—

An Elementary Treatise on Mechanics. Cambridge, 1819.

A Treatise on Dynamics. Cambridge, 1823.

An Introduction to Dynamics. Cambridge, 1832.

On the Free Motion of Points and on Universal Gravitation. Cambridge, 1832.

Analytical Statics. Cambridge, 1833.

An Elementary Treatise on Mechanics. Cambridge, 1833.

Bridgewater Treatise on Astronomy and General Physics. London, 1833.

Architectural Notes on German Churches &c. London, 1833.

Mechanical Euclid. Cambridge, 1837.

History of the Inductive Sciences, 3 vols. London, 1837–38.

Philosophy of the Inductive Sciences, 2 vols. London, 1840. Expanded into History of Scientific Ideas.

The Doctrine of Limits, with the Application &c. Cambridge, 1841.

The Mechanics of Engineering, &c. London, 1841.

Conic Sections, &c. London, 1849.

On the Philosophy of Discovery. London, 1860.

Novum Organum Renovatum.

The Elements of Morality, including Polity, 2 vols.
Lectures on the History of Moral Philosophy in England.
Lectures on Systematic Morality.
Indications of the Creator. (In answer to the "Vestiges of Creation.")

Translations:—

Göthe's Herman and Dorothea.
Auerbach's Professor's Wife.
Grotius' Rights of War and Peace.
Platonic Dialogues for English Readers, 3 vols.

Anonymously:

On the Plurality of Worlds.

In the *Philosophical Transactions*:—

A General Method of Calculating the Angles made by any Planes of Crystals, &c. 1825.
Researches on the Tides, series i. to xiv. 1833–50.

In the *Transactions of the Cambridge Society*:—

On the Position of the Apsides of Orbits of great excentricity. 1821.
On Double Crystals of Fluor Spar. 1822.
On the Rotatory Motion of Bodies. 1827.
On the Angles made by Two Planes or Two Straight Lines, referred to Three Oblique Co-ordinates. 1827.
On the Classification of Crystalline combinations, and the Causes by which their laws of derivation may be investigated. 1828.
Reasons for the Selection of a Notation to designate the Planes of Crystals. 1828.
Mathematical Exposition of the Doctrines of Political Economy. 1829.
On Ricardo's Principles of Political Economy. 1833.
On the Nature of the Truth of the Laws of Motion. 1834.
On the Results of Observations made with a new Anemometer. 1837.
Demonstration that all Matter is heavy. 1840.
Are Cause and Effect Successive or Simultaneous? 1842.
On the Intrinsic Equation of a Curve, and its Application. 1849.
On the Fundamental Antithesis of Philosophy. 1849.
Mathematical Exposition of some Doctrines of Political Economy. 1851.
Of the Transformation of Hypotheses in the History of Science. 1851.

On Plato's Survey of the Sciences. 1856.
On Plato's Notion of Dialectic. 1856.
Of the Intellectual Powers according to Plato. 1856.
On the Platonic Theory of Ideas. 1858.

Besides the above, there are numerous important papers scattered through the *Reports of the British Association* and other scientific publications.

Hermann Goldschmidt, one of the most indefatigable and at the same time one of the most disinterested amateur observers of the present age, was born at Frankfort-on-the-Maine on the 17th of June, 1802. He came into the world with a weak body, and, in his early days, suffered such delicate health that all the tender care of his parents was required to nurture and sustain him. Destined originally for a commercial life, he spent some dozen years in his father's warehouse, devoting his leisure hours to the study of modern languages and the cultivation of the painter's art. To this latter he at length resolved to apply himself entirely, and to this end he repaired to Munich, where he studied under the celebrated masters Cornelius and Schnorr, settling in Paris to perfect his artistic studies in the year 1836, in which year he exhibited his first picture, "A Woman in Algerian Costume." This was followed by many others which appeared in succeeding years on the walls of the art-exhibitions, and Goldschmidt became eminent as an historical painter; one of his later works, "The Death of Romeo and Juliet," having been commanded by the Minister of State. But we must pass thus briefly over this portion of his history, for it is with the astronomer rather than with the artist that we are concerned.

Goldschmidt had passed the middle time of life when a mere accident first induced him to turn his attention to astronomy. It appears, from his own account, that he suffered much from depression of spirits, and that he resorted to all possible changes of occupation in order to dissipate his melancholy humour. Chance led him one day to the Sorbonne, where he heard a lecture by M. Le Verrier, in the course of which the learned professor explained an eclipse of the Moon that was to occur on the same evening—the 31st of March, 1847. The explanation aroused in him an enthusiastic admiration for astronomy, and he determined to apply himself zealously to the study of the science, of which he had hitherto possessed but vague notions. Towards the close of the year 1849 he procured a little telescope, of not more than 2-inches aperture, which he purchased with the proceeds of the sale of one of two copies he had made at Florence of a portrait of Galileo: he alludes to the acquirement of this instrument as the happiest event of his life.

Three years after, with the help of the Berlin Star-charts, and with either this little telescope, or one a very trifle larger which superseded it, he discovered his first small planet, named by Arago *Lutetia*, and which was detected on the 15th of November, 1852. Steadily pursuing this branch of observation, he year by year added to his discoveries; increasing his telescopic power to 2⅝-inches aperture, he picked up his four succeeding asteroids, *Pomona*, *Atalanta*, *Harmonia*, and *Daphne*. With a still larger, but still comparatively insignificant instrument, one of 4-inches aperture, he found the remaining nine, *Nysa*, *Eugenia*, *Doris*, and *Pales* (these two were discovered on the same night), *Europa*, *Alexandra*, *Melete* (supposed at first to have been *Daphne*, but afterwards found to be an independent planet), *Danaë*, and *Panopea*, which last was found on the 15th of May, 1861. Thus, within a period of nine years fourteen planets were discovered; and when we consider the paucity of the observer's means and the harassing nature of the observations upon which each discovery depended, we cannot but regard such a labour and such a result as unprecedented in the history of observational astronomy. For Goldschmidt had none of the recognised appliances of an observatory; his observing-room was by turns his humble *atelier* on the sixth floor of a *café* in one of the most frequented streets of the Quartier Latin, and by turns the garret forming his sleeping apartment; his area of observation being limited to the regions of the sky which the windows of these chambers commanded.

Although these discoveries form the basis of Goldschmidt's fame as an astronomer, they do not comprise the whole of his labours; he was an assiduous observer of variable stars, stellar satellites, comets, and nebulæ; he also formed one of the band of observers who journeyed into Spain to witness the Solar Eclipse of July 1860. His labours, however, were almost entirely observational. His contributions to the literature of Astronomy consist chiefly of short notices of the results of his observations, or announcements of his discoveries. The longest of his papers is probably that on the above-mentioned eclipse. During the later years of his life, when his failing sight compelled him to relinquish his telescopic work, he seems to have had a tendency to speculative astronomy; for a few months before his death he circulated a memoir on the favourite topic of speculation, the Physical Constitution of the Sun and the origin of Solar Spots. He appears to have applied his artistic powers to astronomical objects, for his memoir on the eclipse was accompanied with three paintings in oil; and in one of his letters to M. Le Verrier he mentions a series of studies in oil which he had made of Donati's Comet.

Although Goldschmidt was not a salaried observer, and derived no direct pecuniary advantage from his astronomical works, his labours did not pass without recognition and encouragement. Eight times the Lalande Astronomical Prize was awarded to him by the Academy of Sciences; the Cross of the Legion of Honour was conferred upon him in 1857; an annual pension of 1500 francs was accorded to him in 1862. He received also the Gold Medal of this Society in the year 1861, and was elected an Associate in May 1866.

In his private life he was esteemed for the modesty of his demeanour and the amiability of his disposition. He died at Fontainbleau on the 30th of August, 1866. J. C.

Proceedings of various Observatories.

Royal Observatory, Greenwich.

The work of the Royal Observatory, Greenwich, during the past year, has been of the usual character. The Moon has been observed at every possible opportunity, on the meridian with the Transit-Circle, and off the meridian with the Altazimuth. The observations are thus extended to feel certain inequalities of the greatest importance for the completion of the Lunar Theory. This completeness has given to the Greenwich Lunar Observations a value which belongs to those of no other Observatory. The work of re-observing all the stars in Bessel's *Fundamenta* has been very nearly completed, and it is intended to collect the results of the Star Observations made from 1861 to 1867 into a new Catalogue. The central cube of the Transit-Circle has been pierced, and a clear view of Collimator from Collimator, through the cube, has been thus obtained. The new collimators, by Simms, have been mounted and put into use. The Great Equatoreal has been employed in observations of occultations of stars by the Moon; in spectrum observations of T *Coronæ* and γ *Cassiopeiæ;* observations of the Crater *Linné*, and in observations of the Sun's photosphere.

An observation of the Sun's disk, made by the Astronomer Royal under very favourable circumstances, appears fully to support the description of the very minute granulation of the Sun's surface, described by Mr. Nasmyth as interlacing willow-leaves and by Mr. Stone as rice-grains, and totally different from the coarse mottling observed long since (consisting probably of unequal groupings of the granulation), and from the thatch-straws seen on the edges of the penumbræ of spots, so graphically described by Mr. Dawes.

In the last autumn an expedition was organised by Prof.

Bache, Director of the Coast Survey of the United States of America, for determining, by means of the Atlantic Telegraph, the difference of longitude between Heart's Content in Newfoundland and Foilhommerum in Valentia; and the Irish portion of the operations was intrusted to our Associate Dr. B. A. Gould. Dr. Gould selected for the site of his temporary observatory a place adjacent to the Telegraph Office at Foilhommerum. No official account of the observations and their result has yet been published; we understand, however, that three successful interchanges of signals were made on nights when sufficient star-observations were obtained, and that the results were satisfactory and accordant. Advantage was taken of the residence of Dr. Gould at Foilhommerum for determining its distance in longitude from the Royal Observatory, Greenwich; and it may serve to show the difficulty of conducting telegraphic longitude-operations in this climate, that, after a protracted sojourn of Dr. Gould in Valentia, only three nights' signals could be exchanged, of which one series was lost through want of clock error at Valentia, so that only two nights are available for use. By the kindness of Colonel Sir Henry James, Director of the Ordnance Survey, the several determinations of longitude in Valentia have all been referred geodetically to one point, namely, the Trigonometrical Station on Feagh Main; and it may be interesting to the Society to be made acquainted with the different results. The longitude of Feagh Main from the Royal Observatory of Greenwich is—

	m s
By conveyance of chronometers from Greenwich to an Observatory on Feagh Main in 1844	41 23·23
By telegraphic communication with an Observatory at Knight's Town in 1862	41 23·37
By telegraphic communication with an Observatory at Foilhommerum in 1866	41 23·19

In the first and second of these operations the personal equations were determined; in the third they have not been determined. The geodetic reference is affected by the irregularities of attraction in a rather hilly island. We cannot however be far wrong in adopting $43^m\ 23^s{\cdot}28$ for the west longitude of Feagh Main.

The volume for 1865 has been nearly passed through the press, and the Reductions for 1866 are very nearly complete. The November Meteors were observed with great completeness. More than 8000 meteors were counted on the night of November 13, 1866. The times of maximum frequency were well determined, and the position of the radiant point fixed with great care. The galvanic operations have been carried on successfully, but without material alterations during the past year.

Radcliffe Observatory, Oxford.

The amount and nature of the work accomplished during the past year at the Radcliffe Observatory is of the same character as in the preceding year. A new list of stars for observation has, however, been compiled by Mr. Quirling, which includes all those stars of the British Association Catalogue which still require observing, together with others included between the seventh and the eighth magnitudes found in various Catalogues. The Sun has been observed whenever the state of the sky permitted it, and the Moon till the first observation after opposition in each lunation. *Mercury* has also been observed whenever it was visible on the meridian. The number of stars observed in 1866 is 980; while of the Sun 93 observations have been made; of the Moon 53; and of *Mercury* 28. The weather, however, during the year 1866 was exceptionally bad.

The heliometer was employed by Mr. Main for the observation of double stars as usual during such portions of the year as permitted it.

Five occultations of stars by the Moon were observed, and the time of commencement of the Solar Eclipse of October 8, 1866.

Advantage has been taken of the relative scantiness of the observing, for pushing forward the reduction of the observations, and with so much success that there are at present very few arrears. The transits are reduced to the end of 1866, excepting the corrections to mean places of unknown stars (that is, those not included in the B.A.C.); and the zenith distances are in a forward state. The astronomical reductions for 1865 are essentially complete. The meteorological reductions are however not so advanced, those for 1864 (the volume in the press) not being quite completed.

Advance has also been made in the printing of the Observations. The Astronomical Observations for 1864 are completely printed, together with an elaborate introduction; and a few copies have been sent to the chief observatories in England and Scotland.

The printing of the volume for 1865 is also commenced, and with a small difference of arrangement; namely, that the mean results of right ascensions and north polar distances are placed side by side in the same section, and the means of the observations are exhibited. This arrangement is considered by Mr. Main to be a very great improvement.

Of the extraordinary works of the past year, the most remarkable was the observation of the grand meteoric display of November 13, in which the Radcliffe Observatory took a full share. A great number of individual meteors were observed specifically, and the whole number counted was 3087.

It would appear therefore that this Observatory has been as successful as in former years, in carrying out fully the plan of observation and the amount of work which had been proposed by its Director. A volume of its astronomical and meteorological results is published annually, and the reduction and thorough discussion of the observations are at the present time in as forward a state as is desirable or possible. By its means all the stars in the Catalogue of the British Association which are visible in the Northern heavens will shortly have been reobserved, and, in consequence, a reliable place will be found for all stars which are individually of much value for comparison, in the various branches of astronomy; while, at the same time, this amount of work has been accomplished with the most rigorous regard to fundamental accuracy, and to the elimination of every source of constant error from the results. The meteorological observations, with their elaborate discussions, form a serious addition to the labours of the Observatory, though they probably add to its reputation; and their utility will perhaps be better recognised as years roll on, and especially when all observatories which are charged with the determination of the climates of their localities shall have been provided with self-recording apparatuses.

Cambridge Observatory.

The same course of observation as that of last year has been steadily pursued with a view to the completion of the Catalogue of Stars selected from the *Histoire Céleste.* A little more than 200 transit and 500 circle observations are still needed to make up the prescribed number.

A continuous effort has been made throughout the year to bring up the arrears in the reductions and to keep pace with the current observations. As a rule, hardly ever departed from, the entries from the note-books into the reduction-books for each night are made on the following morning; the means taken, and the correction for irregularity of pivots in the transit, and for runs in the circle, are applied. The Transit Instrument is reversed about once a month; and the remaining instrumental and clock corrections are calculated and applied as soon as possible afterwards, so that the apparent right ascensions are obtained up to the time of the last reversal. The level and collimation errors are obtained independently in each position of the axis, the reversal being used merely as a means of verification. The mean Right Ascensions for the beginning of each year are deduced to the end of 1865, and those for 1866 are in progress. The constants for obtaining the apparent from the mean place are computed for the selected list of Lalande's Stars, and for a few others. The mean

Right Ascensions from the separate observations of each star for the year are brought together as far as the end of 1863.

The apparent North Polar Distances are nearly completed to the end of 1866; the reductions to mean places are computed to the end of 1865, and are applied to the end of 1862. In order to get the reductions thus far advanced, it has been found necessary to employ an additional computer.

The carrying out of the contemplated series of meridian observations has left but little time for observations with the Northumberland Equatoreal. A Spectroscope intended to be used with this instrument has lately been constructed by Mr. Browning.

The Meteorological Observations have been carefully attended to. Their value is now increased by the erection of a Robinson's Anemometer.

Especial attention was given to the November Meteors. The courses of a large number have been deduced from the records of one or two observers; careful determinations of the position of the radiant point were made independently by Professor Challis and Professor Adams; and efforts were made by several other observers to count the total numbers in given intervals of time from the commencement of the display. A new Meteoroscope has been made by Mr. Simms, under Professor Adams' direction, according to a plan which, it is hoped, will secure greater rapidity, accuracy, and completeness in the observations.

The cost of this instrument, as well as of the Spectroscope and Anemometer, is defrayed by a grant from the Sheepshanks Fund.

Royal Observatory, Edinburgh.

Her Majesty's Government having supplied the necessary means, some essential repairs to instruments are being made. Books and transactions, received in many past years from foreign observatories and other scientific institutions, are being put in order. A little extension of the buildings of the Observatory, however, appears necessary; and the Astronomer has now proposed to a meeting of the Board of Visitors a plan for that purpose.

Of work performed, the next most constant and regular to the time-service by ball, and gun, and Jones's controlled clocks (of which six additional ones have been established within the year for the service of the new Post Office), is the reduction of meteorological observations for Scotland; ever pressing, not only from their representing fifty-five stations, but from having to be printed punctually every month and every quarter.

Meridian observations of stars with the Transit Instrument and Mural Circle have been carried on as usual.

Glasgow Observatory.

The operations at the Glasgow Observatory have not been distinguished by any feature of novelty during the past year. The Transit Circle continues to be employed in the steady prosecution of a series of star-observations, the objects chosen for this purpose generally falling below the sixth magnitude. The Ochtertyre Equatoreal has been mainly devoted to the measurement of a select number of the more interesting double stars contained in Struve's great Catalogue.

The operations for supplying the city of Glasgow with the advantages of true time continue to give unqualified satisfaction. A new wire has recently been erected chiefly with the view of being employed in transmitting Greenwich mean time to the shipping interests of the Clyde, and several clocks have been placed in connexion with it. The system now embraces eighteen clocks in the City and Port of Glasgow, which are maintained in perpetual control by a current of electricity directed from the normal mean time clock of the observatory.

A course of meteorological observations has been regularly prosecuted for some years past at the Glasgow Observatory, but except in the case of Osler's Anemometer the principle of continuous self-registration has not been employed. Professor Grant has reason to believe that this important defect will soon be remedied.

Report upon the Madras Observatory for the Official Year 1865, May 1st, to 1866 April 30th.

1. Notwithstanding the continued urgent want of European assistance, the proceedings of the Madras Observatory may be pronounced, upon the whole, more satisfactory than for several past years. The work accomplished has been throughout above the average amount in quantity, and when submitted to the test of publication will, it is hoped, be found equal in quality to any reasonable expectations on the part of the astronomical public. That great desideratum, however, publication, remains a matter of impossibility with the present insufficient establishment.

2. The construction of a convenient and suitable room, with a revolving dome, for the new Equatoreal, has at last been accomplished by Messrs. Leggett and Broomhall of Madras, in a most creditable and efficient style. The interior diameter of the dome is sixteen feet. Its rotation is effected by means of eight six-inch rollers or wheels, the axles of which are connected by a ring of hard wood, as in the much larger domes employed by Mr. Lassell of Liverpool, described in the twelfth volume of the *Memoirs* of the Royal Astronomical

Society. Notwithstanding the size and weight of the new dome, its motion is so smooth and perfect, that the pressure of a finger, or the single-handed force of a child of eight years of age, suffices to start it, while it stops dead wherever required. Two sliding shutters, easily opened, expose an observing slit three feet in aperture, and extending over nearly two-thirds of the dome, or from the horizon to about twenty-five degrees beyond the zenith. The new Equatoreal, by Messrs. Troughton and Simms of London, has been erected, and worthily sustains the high reputation of its makers. It is supported by a central iron pillar, on what is known as the German plan of mounting; and for steadiness, perfect equilibrium, and convenience in its mechanical details, it is all that the most fastidious could desire. Owing to the prevalence of bad weather since its very recent erection, no opportunity has yet occurred for finally adjusting or critically examining its eight-inch object-glass; but as this was duly tested and approved by the Astronomer Royal at Greenwich, before the instrument left England, it may be justly expected that it will prove as satisfactory in this important point as it has already been found in its mechanism. It is liberally equipped with all the usual appliances in the way of eye-pieces &c., and is also provided with an excellent parallel wire micrometer and a double-image micrometer of Mr. Airy's construction.

The former Equatoreal, by Messrs. Lerebours and Secretan, is in fair working order. Other extra-meridional instruments belonging to the Observatory are, a five-foot telescope, with a zodiacal portable stand, far from steady, and a good universal equatoreal stand, provided with three different telescopes, viz., two of three feet, and one of five feet focal length, the latter having been made up in Madras by Mr. F. Doderet, Mathematical Instrument-maker to the Public Works Department, with the object-glass (by Dollond) formerly used in the old and now discarded transit instrument. In the meridional department, the transit circle, also by Messrs. Troughton and Simms, continued to yield unexceptionable results from June 1862, the commencement of its career, until the end of March 1866, when symptoms of unsteadiness in the circle clamps suddenly appeared, which have given much trouble and anxiety during the last month of the official year. It is now undergoing repair in Mr. Doderet's hands, and will, it is confidently hoped, soon regain the former high character for permanence of adjustment and general excellence which it has so worthily maintained during the past four years. The old arrangement of shutters, most objectionable and inconvenient, opening in four sections, and never weather-proof, has been superseded by a single flap, twenty-three feet in length by two in breadth, counterpoised, and opening from within by means of ropes and pulleys in the usual manner. The magnetical and meteorological instruments are in fair working order, but those of the former class, in use since 1841, are by no means equal to those now constructed and used in European Observatories. The Anemograph, by Mr. Adie of London, is in satisfactory condition, and stood the test of two tolerably severe gales in 1865, without injury or failure.

3. The observations with the transit circle have been made throughout the year by the two head native assistants, as usual, and it may be remarked with pleasure, that their care and assiduity have secured results highly creditable to themselves, and of great value to science. The steady progress of the meridian observations will be best shown by the subjoined tabular statement of work done since the erection of the instrument in May 1862. The number of observations taken stands thus for the successive official years :—

Observations of	Moon.	Planets.	Stars.	Total.
1862–63	54	85	1723	1862
1863–64	70	77	2272	2419
1864–65	64	119	2409	2592
1865–66	55	91	2599	2745

We have, therefore, 9618 complete observations of Right Ascension and Polar distance, taken in three years and eleven months (1862–66), awaiting publication, averaging 2443 per year ; a large per-centage of which refers to stars in the Southern hemisphere, the positions of which have not been previously determined at any other Observatory. Reductions of standard stars and all instrumental corrections are kept rigorously up to date. Those of other objects are but little behind, being completed up to December 31st, 1863, and very nearly so up to October 1865.

The old Equatoreal has been employed chiefly in the construction and revision of the Atlas of Variable Stars in hand for several years past. Twenty-three observations have been taken of the five planets, *Isis*, *Ariadne*, *Hestia*, *Asia*, and *Sappho*, and numerous comparisons of variable stars have been made throughout the year. The periodical comets of Faye and Biela were sought for unsuccessfully, the former being much too faint for the telescope, and the latter having, doubtless for the same reason, eluded the pursuit of Astronomers generally, even when provided with instruments of the largest size. None of the equatoreal observations of planets or comets are yet ready for publication, but it is hoped that this year will be the last in which such will be the case.

4. Two small telescopic Variable Stars and one new Minor Planet have been discovered since the last report was written ; of these Z *Virginis* had been previously mapped as an ordinary star of the tenth magnitude, but was found to have vanished

entirely in 1865. The other new variable X *Capricorni* was first seen and observed as a supposed new planet on July 26th, 1865. Neither the periodic time between two successive maxima, nor yet the range in regard to brilliancy of either of these objects, can yet be decided. Another new Planet was discovered on May 16th, 1866, in the constellation *Scorpio*, extremely faint, being but little brighter than a twelfth magnitude. The name selected for this 87th member of the asteroidal group is *Sylvia*, one suggested by Sir J. F. W. Herschel a few years back as suitable for a future new planet. From its slower apparent motion than that of most others when similarly situated, it has evidently a considerable mean distance from the Sun, but its orbital elements have yet to be calculated.

5. Magnetical and Meteorological Observations continue to be made three times daily as formerly ; and the results of the latter are published in the *Fort Saint George Gazette*, and in one local newspaper. The arrears of the twenty years' series of hourly observations have been nearly worked up, and printing has been proceeded with so as to ensure publication at no distant period. The curves of hourly corrections for the barometer and dry and wet bulb thermometers will be of great service throughout India, as it is evident that they must be far more fairly applicable to tropical registers than those derived from observations made in the widely different climate of Europe. The early and remarkable heat of 1866 exceeded any previously recorded at Madras. The thermometer reached 110·6 in the shade on May 28th, the depression of the wet bulb being 35·8, and the per-centage of humidity so low as 16. A scheme for meteorological registrations is now under the consideration of Government which, if sanctioned, will greatly extend our knowledge of the climate of Southern India, and its important bearing upon the statistics of health, mortality, and the cultivation of the staple productions of the country.

6. The Rain Returns maintained with more or less regularity at upwards of 350 stations since 1852, under the control of the Revenue Board, are under discussion, and though many will doubtless have to be rejected as untrustworthy, sufficient will remain to furnish an interesting rain-map of the Presidency, showing the comparative influences of elevation above sea-level, and proximity to the coast, in a marked and highly instructive manner. New gauges of an improved and uniform pattern are about to be issued, and it is hoped that the increased accuracy of future returns will amply compensate for the additional outlay involved thereby.

7. The Madras mean time of the flash of the 8 P.M. gun has been carefully noted, and published as formerly, to facilitate the rating of chronometers in the Roads. It is intended as early as possible to carry out the long contemplated tele-

graphic discharge of the Fort and Mount guns, and the erection of three sympathetic electrical clocks, for the convenience of the public in various parts of Madras.

Durham Observatory.

At the Durham Observatory the principal observations have been those of the Minor Planets, especially of those most recently discovered. From observations made of the Planet *Io*, at Durham and elsewhere, at its first discovery, the observer, Mr. Dolman, calculated and published elements, corrected for the perturbations of *Jupiter* and *Saturn*. The ephemeris deduced from these elements has been found to agree sufficiently well with observations made at the present reappearance of the planet near opposition.

A few series of positions of planets at their first observations have been communicated to the *Astronomische Nachrichten*, and the rest will soon be published in the same manner.

The Equatoreal has lately been provided with a Spectroscope by Browning, London; but observations with it have not yet been commenced.

Liverpool Observatory.

The transfer of the instruments from the old Observatory on the Waterloo Dock Pier Head to the new Liverpool Observatory, Bidston, Birkenhead, is now nearly completed. Mr. Hartnup moved into the new house on the 22nd of December, but the transit room was not ready for the instrument until the 23rd of January; the chronometers were removed on the 25th of January; the new chronometer room is partly erected, and Messrs. Troughton and Simms are making preparations for the re-erection of the Equatoreal. The Barograph, the tube of which contains a column of mercury three inches in diameter, has been removed; the tube was let down to the bottom of the cistern, and the space between the cistern and tube calked, in this way it was successfully taken to the room prepared for it in the new building without any injury to the instrument. The telegraph wires are being laid for the transmission of galvanic currents from the Observatory to a seconds clock to be erected on the margin of the river opposite the Prince's landing-stage; a time-gun will be discharged by this clock, the movements of which will be controlled from the new Observatory.

In addition to the rating of chronometers, preparations are being made for testing ship's compasses, sextants, barometers, and thermometers; the conditions under which nautical instruments will be received and tested at the new Observatory have not yet been decided on.

Kew Observatory.

The Kew Photoheliograph has been employed in taking pictures of the Sun, whenever possible. In consequence of an arrangement made by the Kew observers with Hofrath Schwabe, of Dessau, the results at which both arrived with regard to numbers of new groups are now simultaneously published at the end of every year, in the *Monthly Notices*. Looking at these tables for 1865 and 1866, it was found that, although Hofrath Schwabe had, during these years, 656 days of observation against only 306 at Kew, still the total number of groups of Sun-spots observed at both places agrees precisely for each year. The differences observable in the numbers for each separate month are accounted for by the fact that, towards the end of a month, through unfavourable weather, new groups are very often observed later at Kew than by Hofrath Schwabe, and are hence distributed over different months by these respective observers. These two years' observations, therefore, show that the Kew method of observation has now reached a degree of reliability, as regards the ultimate results, which leaves nothing to be desired. In addition to the mere numbering of groups, the area of the spotted surface will in future be measured at Kew from day to day, by means of a convenient eyepiece attached to Mr. De La Rue's well-known instrument for determining the heliographic position of the spots; and the Kew observers hope thus to supply most valuable material for investigations of any nature connected with Sun-spots.

In a second paper, on Solar Physics, recently published, the authors, Messrs. De La Rue, Stewart, and Loewy, adduce evidence, chiefly derived from laborious measurements of the areas of Sun-spots observed by Carrington from 1853 to 1860, of the influence of planetary configurations on the behaviour of Sun-spots; and they arrive at the following results:—

1. That the behaviour of Sun-spots, which pass the same ecliptical longitude at the same or nearly the same time, is similar, and is therefore affected by some external influence; and that there is a period, or recurrence of the same behaviour, every nineteen or twenty months.

2. That in all these recurrences the phenomena always progress from left to right of the Earth, or in the direction of the motion with reference to the Earth, of the inferior planets; and that the equality in the synodical period of *Venus* (583 days) and the period of recurrence of similar behaviour in Sun-spots, points to *Venus* as the planet which apparently exerts the most predominating influence, although an influence of other planets, particularly *Jupiter*, is distinctly traceable.

3. That the nature of this planetary influence consists in a tendency to produce the maximum of Sun-spot activity on that

side of the Sun which is turned away from the influencing planet, and on the other hand, in a tendency to diminish the size of Sun-spots on that side which is turned towards it. Similarly, it would appear, with regard to *Venus*, that spots are nearest to the solar equator when the heliographical latitude of *Venus* is 0°, and are most distant from the solar equator when this planet attains its greatest heliographical latitude. This last point was brought prominently under the notice of the authors by a recent interesting circular by M. Chacornac, and is the subject of further investigation.

Messrs. De La Rue, Stewart, and Loewy, state that they are now actively engaged in preparing two new parts (iii. and iv.) of their "Researches" for publication in the course of the present year. One will contain the calculated positions of Sun-spots observed with the Kew Photoheliograph, and a deduction from those positions of the elements of rotation of the Sun. For the other paper the authors have proposed to themselves an investigation of planetary influence on Sun-spots, extending over the whole of Hofrath Schwabe's observations, with a view to separate more distinctly the action of each single planet, and thus of arriving, if possible, at an insight into the laws of planetary influence on solar activity.

Another problem, bearing on physical astronomy, which is to be worked out at Kew, under the direction of Mr. Stewart, is the proposed determination of the length of the seconds pendulum there. This work stands in connexion with the Indian pendulum experiments, for which the Kew Observatory forms the fundamental station. The preliminary experiments with Captain Kater's reversible pendulum, for careful determination of various necessary coefficients, have been completed during the past year, and will shortly be published.

Mr. De La Rue's Observatory.

At Mr. De La Rue's Observatory, at Cranford, besides the current work, special photographic observations of the Moon have been made and are still in progress, with the view of assisting in the investigation of an alleged change of visibility of the crater *Linné*, situated in the plain of the *Mare Serenitatis*. It is fair to assume that if any such change has taken place, the district immediately surrounding the crater will have been affected by it; and photography affords a ready means of determining this point. As to the minute crater itself, none but the stillest nights will be available for its delineation by photography; for, except on those rare occasions, the undulations of the atmosphere cause the projected image of the crater to dance over an area as great as that occupied on the plate by the crater itself. Up to the present time, a comparison of photographs taken in 1858 by Mr. De La Rue and 1866 by Mr. Reynolds respectively has not elicited any apparent change in the vicinity of *Linné;* but further investigations are necessary before it can be positively affirmed, on the evidence of photography, that no such change of visibility has taken place.

The 13-inch photographic object-glass, ordered of the Messrs. Cooke, has not yet left their hands; but it is expected to be completed in the early part of the present year.

Mr. De La Rue has also ordered of Mr. George With, of Hereford, a 13-inch silvered glass speculum, with the view of comparing its performances with that of his own mirrors. Many of our Fellows are acquainted with Mr. With's productions, and may therefore feel interested in this competition between a 13-inch mirror of his manufacture and one of the same dimensions figured by Mr. De La Rue himself.

Mr. Huggins' Observatory.

At Mr. Huggins' Observatory, Upper Tulse Hill, observations on the spectra of the heavenly bodies have been continued.

Mr. Huggins has attempted the prismatic analysis of the light of other Nebulæ and Clusters. The light of many of these faint objects was found to be insufficient for a certain determination of the characters of their spectra. The examination of the following Nebulæ and Clusters was more satisfactory.

Nebulæ, the spectra of which consist of one or more bright lines:—

No. 385	76 M.	No. 386	193 H. I.
2343	97 M.		

Nebulæ, the spectra of which are apparently continuous:—

No. 342	100 H. I.	No. 1771	2 H. I.
352	17 H. V.	1823	205 H. I.
544	23 H. IV.	2008	163 H. I.
600	77 M.	2360	270 H. I.
1137	261 H. I.	2413	194 H. I.
1713	200 H. I.	2600	173 H. I.

The numbers in the above lists refer to Sir John Herschel's General Catalogue.

Lists of the Nebulæ and Clusters observed by Mr. Huggins during former years will be found in the Annual Reports of 1866 and 1865.*

* *Monthly Notices*, vol. xxv. p. 107, and vol. xxvi. pp. 144, 220.

The description "*continuous spectrum*," in these lists must not be understood to mean more than that, when the slit was made as narrow as the feeble light of the object permitted, the spectrum was not resolved into bright lines. The irregular brightness of many of the spectra classed as continuous suggests that probably either dark or bright lines are present.*

In August, 1864, Mr. Huggins recorded a peculiarity presented by the continuous spectra of the Great Nebula in *Andromeda* and its small but bright companion:—"The spectrum appears to end abruptly in the orange; and throughout, its length is not uniform, but is crossed either by lines of absorption or by bright lines." In May last the spectrum of the light of the central condensed portion of the cluster 13 M. *Herculis* was found to possess similar characters. The absence of the red, and of part of the orange rays, may be caused by absorbent vapours, through which the light has passed. The *apparently complete* want of light in this part of the spectrum, and the irregular appearance of the brighter parts of the spectrum, suggest, perhaps, that the light may have emanated from a gaseous source, and that the spectrum may consist of bright lines. The faintness of these continuous spectra has prevented the employment of a slit sufficiently narrow for the determination of their true character. The bright points of some clusters may, therefore, possibly not possess a physical constitution similar to the Sun, and the brighter of the separate stars.

For the purpose of ascertaining how far the arrangement of the nebulæ by the prism into two classes corresponds with the indications of their resolvability into bright points afforded by the telescope, Lord Oxmantown examined all the observations made at Parsonstown of 60 nebulæ which had been subjected to prismatic analysis by Mr. Huggins.

These Nebulæ may be arranged thus:—

	Continuous Spectrum.	Gaseous Spectrum.
Clusters	10	0
Resolved, or resolved?	5	0
Resolvable, or resolvable?	10	6
Blue or green, no resolvability	0	4
No resolvability seen	6	5
	31	15
Not observed by Lord Rosse	10	4
	41	19

On May 16 Mr. Huggins received letters from Mr. Birmingham of Tuam, and Mr. Baxendell, announcing the ap-

* *Philosophical Transactions*, 1866, p. 381.

pearance of a bright star in *Corona Borealis.* The same evening, in conjunction with Dr. W. A. Miller, Mr. Huggins observed the remarkable compound spectrum of this star. An account of their observations of this star has appeared in the *Monthly Notices.**

On September 15, Mr. Huggins was informed by Mr. Baxendell that T *Coronæ* had increased in brightness about two magnitudes from August 20. On several nights, up to October 8, the spectrum of T *Coronæ* was observed, but the determination of the characters of the spectrum was in some degree uncertain on account of the feeble light of the star. The bright lines, which were so conspicuous before the star reached its minimum were not *certainly* seen, and the part of the spectrum where they occur was not much, if in any degree, brighter than the adjoining parts.

The spectrum of γ *Cassiopeiæ* appears to be in some respects analogous to that of T *Coronæ.* In addition to the bright line near the boundary of the green and blue observed by Father Secchi, there is a line of equal brilliancy in the red, and some dark lines of absorption. The two bright lines are narrow and defined, but not very brilliant. Micrometrical measures of these bright lines show that they are doubtless coincident in position in the spectrum with Fraunhofer's C and F, and with two of the bright lines of luminous hydrogen. In these stars part of the light must be emitted by gas intensely heated, though not necessarily in a state of combustion. The nearly uniform light of γ *Cassiopeiæ* suggests that the luminous hydrogen in this star forms a normal part of its photosphere.

Observations have been made during the past year of the form and size of the bright particles which constitute the solar photosphere. Some of the results of this examination of the Sun's surface have appeared in the *Monthly Notices.*†

The spectra formed by the light from different parts of a solar spot have been examined. At present no certain modification of the solar spectrum has been detected.

Mr. Fletcher's Observatory.

Mr. Fletcher is still following out the work to which allusion is made in our last Report, viz., the reobservation of all the objects in Smyth's *Cycle.* The time that Mr. Fletcher is able to give to Astronomy is devoted exclusively to this work.

The Fellows will learn with regret that the Observatory of Downside College, near Bath, was completely destroyed by

* Vol. xxvi. pp. 275, 297. Also *Proceedings of the Royal Society*, vol. xv. p. 146.
† Vol. xxvi. p. 260.

fire on Sunday the 20th of January, 1867. This Observatory contained an equatoreal refractor of $14\frac{1}{2}$ inches aperture, by Slater, a transit-circle, and other instruments, and had been completed only a few months since at an expense of nearly 3000*l*. Unfortunately neither the building nor its contents were insured; it is supposed that the disaster was caused by the overheating of a flue.

The Progress of Astronomy.

Southern Survey.

It will be a matter of great gratification to the Fellows of the Society, and to all interested in the advancement of our Science, to learn that the work of the great Southern Survey is in actual progress. The work has been undertaken by observers of acknowledged skill and energy, and the completion of this important work may now be confidently expected.

Asteroids.

During the past year six asteroids have been discovered.

(86)	Semele	by Tietjen on 1866	Jan.	4
(87)	Sylvia	Pogson	May	16
(88)	Thisbe	C. H. F. Peters	June	15
(89)	——	Stéphan	Aug.	6
(90)	Antiope	Luther	Oct.	1
(91)	——	Stéphan	Nov.	4

The number of the Asteroids already discovered is 91. This number is so great, that difficulty is experienced in obtaining Ephemerides sufficiently accurate for the identification and observation of these minute bodies on the meridian. This difficulty is a growing one. It will have to be met by combined systematic action, or many members of this system will ultimately be lost. The perturbations produced by *Jupiter* in the orbits of some of the Asteroids will, probably, ultimately furnish us with our most accurate determination of the mass of *Jupiter*. It is with great pleasure that we recall the attention of the Society to Krüger's determination of the mass of *Jupiter* from the perturbations which it produces in the orbit of *Themis*.* The mass thus obtained is in perfect accord with the result derived from the motions of *Jupiter's* Satellites by Airy and Bessel.

Comet I. 1866.

This Comet, the only known one of the year, was discovered by Tempel, 1865, Dec. 19. The Comet was well observed, and passed its perihelion in the early part of January. Elliptic elements of its path were calculated by D'Arrest and Oppolzer. The excentricity however was large, and the part of its orbit described during its visibility small. The elements discriminating the elliptic motion are consequently not well determined. The periods assigned by D'Arrest and Oppolzer differ greatly. They are respectively 53 and 20 years.

Attention may here be called to a most curious and interesting speculation of Sig. G. V. Schiaparelli, that the Comet II. of 1862 is nothing more than one of the August meteors. Schiaparelli assumes for the radiant point of the August meteors in 1866,—

R.A. 41° N.P.D. 34°

and takes for the maximum of frequency

August 10·75 days.

He thence deduces the following parabolic orbit for these meteors :

Passage of Perihelion	23·620 July
Passage of descending Node	10·75 August
Longitude of Perihelion	343° 28′
Longitude of Ascending Node	138° 16′
Inclination	64° 3
Distance of Perihelion	0·9643
Motion retrograde	

The elements of the orbit of Comet II. 1862, are according to Oppolzer :

Passage of Perihelion	22·9 August 1862.
Longitude of Perihelion	344° 41′
Longitude of Ascending Node	137° 27′
Inclination	66° 25′
Distance of Perihelion	0·9626
Motion retrograde.	

Duration of revolution 123 years.

* An abstract of Krüger's paper, by Mr. Lynn, will be found in the *Monthly Notice* for Nov. 9.

The agreement of these elements is striking. From this agreement Schiaparelli infers that the Comet II. of 1862 is nothing more than a very large meteor of the August system.

On Jan. 22, 1867, M. Stéphan discovered a telescopic comet at Marseilles.

Change on the Moon's Surface.

It is the opinion of Dr. Schmidt that changes are in visible progress on the surface of the Moon. Dr. Schmidt has been acquainted with the appearance of the Crater *Linné* since 1841, and able to see it, as a crater, with the optical means at his disposal, with ease. In the months of October and November 1866 this was no longer the case, even under the most favourable circumstance of illumination. The place of *Linné* appeared covered by a whitish cloudy patch. The crater appears to be now visible in our best telescopes, but no one unacquainted with the appearance formerly presented by *Linné*, from actual observation, can be in a position to speak definitely with respect to the nature of the changes which are supposed to have been in progress. Further information from Dr. Schmidt is awaited with great interest.

The Outburst in T *Coronæ.*

The most startling astronomical event of the past year has undoubtedly been the late outburst in the Star No. 2765 of Argelander's *Bonner Sternverzeichniss*, Zone + 26°. This Star, estimated by Argelander in 1855 as of the 9·5 magnitude, was seen by Mr. Birmingham at Tuam on May 12, between $11^h\ 30^m$ and $11^h\ 45^m$ local time, as a star of the 2nd magnitude. Dr. Julius Schmidt, of Athens, is perfectly convinced that the star was below the 4th magnitude at 11 P.M. Athens local time, on May 12. If the negative evidence of Dr. Schmidt can be trusted on this point, and his testimony on such a point must be entitled to the greatest weight, the star must actually have changed from below the 4th to the 2nd magnitude in less than three hours. An interesting series of observations of the magnitudes of this Variable, by Mr. Baxendell, will be found in the *Monthly Notice* for November 9, 1866. The important spectrum observations of this star by Mr. W. Huggins and Dr. W. A. Miller, fall naturally within the scope of our President's speech. It may however be mentioned, that, of the four bright lines seen by Messrs. Huggins and Miller, three were measured in position at the Greenwich Observatory, where a fourth, not apparently seen by Messrs. Huggins and Miller, was detected. Traces of the brightest lines were also observed with the great Equatoreal of the Greenwich Observatory, when the star had diminished below the 8th magnitude.

γ Cassiopeiæ.

An important discovery has been made by Father Secchi that the spectrum presented by T *Coronæ* is not perfectly unique amongst Star spectra. In the *Astron. Nach.* No. 1612, under date of 1866, August 23, Father Secchi states that the spectrum of *γ Cassiopeiæ* has one bright line in the place of Fraunhofer's solar line F, and several others too faint for position-measurement. This discovery of Father Secchi is the more unexpected, from no indications of variability having been detected in the star.

In a communication to the *Comptes Rendus*, tome lxiii. No. 16, under date September 8, 1866, Father Secchi also states that a spectrum of similar character is presented by *β Lyræ*. In the case of *β Lyræ* the lines are stated to be distinguished with great difficulty.

Celestial Photography.

An interesting and important extension of Photography to Astronomy has been lately made by Mr. Rutherford, of New York. Mr. Rutherford has succeeded in obtaining photographic impressions of stars down to the $8\frac{1}{2}$ magnitude, and over an area of a square degree. On the evening of 1866, March 10, Mr. Rutherford obtained three photographs of the *Pleiades*. With an exposure of four minutes he obtained impressions of forty stars. Dr. Gould has deduced from these plates the relative position angles and distances of the stars. A comparison of his results with those obtained by Bessel by direct micrometrical measurements proves at once the accuracy of the new method and the small amount of relative change which has taken place in this system during the last quarter of a century. The observations made by Bessel extended over more than eleven years. The observations of Mr. Rutherford were made in a single night, the subsequent reductions being made at leisure. Such is one of the results of the combined action of astronomers and chemists within the last few years.

The Companion of Sirius.

In our *Notice* for May will be found an interesting paper by M. Otto Struve, in which he endeavours to prove that the small star discovered by Mr. Alvan Clark near *Sirius*, is in physical connexion with that star, and the cause of the observed irregularities of its proper motion. M. Otto Struve compares his position angles and distances made from 1863 to 1866 with the results of the theoretical investigations of Dr. Auwers, "On the orbit of the disturbing body which produces the irregularities in the proper motion of *Sirius*" (*Ast. Nach.* No. 1506.) The agreement found between the observed and calculated quantities appears satisfactory; but the disturbing body is required to have a mass only less by about a third than that of *Sirius* itself. The star discovered by Alvan Clark appears at most of the 8th magnitude. Its physical constitution must therefore be very different from that of *Sirius* if it really be the disturbing body. If this most interesting speculation is confirmed we shall have a second independent astronomical discovery by theory,—a companion to the brilliant discovery of *Neptune*. An investigation, by Professor Newcomb, based upon different materials, but leading to a similar result, will be found in the *Astr. Nach.* 1584.

Reduction of D'Agelet's Observations.

An important addition to our Catalogues of ancient observations has lately been made by Dr. B. A. Gould. Dr. Gould has reduced the observations of fixed stars made by D'Agelet, at Paris, from 1783 to 1785. These observations were made with a Bird's Quadrant, which appears to have been seriously distorted by some accident. The method of reduction adopted is in essence differential, and the results depend fundamentally on the places of stars in the "Time Star List," prepared by Dr. Gould for the United States Coast Survey. By the process adopted the systematic errors of the instrument appear to be eliminated, and the Catalogue will probably form the best means at our disposal for the determination of the proper motion of all the stars which it contains and which are not contained in Bradley or Piazzi. The number of stars of which places are contained in the Catalogue is 2907.

Tables of the Planet Neptune.

During the past year Professor Newcomb has published New Tables of the Motion of the Planet *Neptune*. The objects proposed are stated as follows:—

1. To determine the elements of the orbit of *Neptune* with as much exactness as a series of observations extending through an arc of forty degrees will admit of.

2. To inquire whether the mass of *Uranus* can be concluded from the motions of *Neptune*.

3. To inquire whether these motions indicate the action of an extra-Neptunian planet, or throw any light on the question of the existence of such a planet.

4. To construct general tables and formulæ by which the theoretical place of *Neptune* may be found at any time, and, more particularly, at any time between the years 1600 and 2000.

Professor Newcomb has not fully calculated the great inequalities resulting from the near commensurability of the mean motions of *Uranus* and *Neptune*, but has treated the effects produced as secular terms. The uncertainty attached to the mean motion of *Neptune* appears to render this course advisable. The greatest care has been taken to free the observations employed from systematic errors depending upon differences in the adopted places of fundamental stars of reference. Professor Newcomb concludes that the orbit of *Neptune* is not yet sufficiently well known to render the discovery of an extra-Neptunian planet (if such exists) by the disturbance it produces in the orbit of *Neptune*, at present possible.

Delaunay's Lunar Theory.

At the present moment are issuing from the press the last sheets of the second volume of Delaunay's great work on *The Lunar Theory*. This volume contains the completion of the problem proposed in the preface to the first volume:

"Déterminer, sous forme analytique, toutes les inégalités du mouvement de la Lune autour de la Terre, jusqu'aux quantités du septième ordre inclusivement, en regardant ces deux corps comme de simples points matériels, et tenant compte uniquement de l'action perturbatrice du Soleil, dont les mouvement apparent autour de la Terre est supposé se faire suivant les lois du mouvement elliptique."

Although the calculations are generally only carried to the seventh order, Delaunay has pushed the approximations to the ninth order in several inequalities where the convergency is slow.

The coefficients of all tbe inequalities are preserved in a literal form. Few who have considered the question will, we think, deny the great advantages resulting from this in the ease with which the results obtained can be compared with former investigations, the facility with which mistakes can be discovered and remedied, and the readiness with which the corrections resulting from improved data can be calculated.

In the second volume will be found the expressions for the longitude, latitude, and parallax, and the numerical values of the different terms. The numerical data are principally derived from Professor Airy's "Reductions of the Greenwich Lunar Observations."

In a third volume Delaunay promises to complete his Theory of the Motion of the Moon, by calculating the effects which result from the secular and periodic inequalities of the Sun's motion, the figures of the Moon and Earth, and the disturbing action of the planets. When the theory is thus completed, we hope that the formulæ will be reduced into tables. It would be out of place here to discuss the merits of the method adopted by Professor Delaunay for the integration of the differential equation of the Moon's motion; a method differing essentially from those adopted by his predecessors;

The method is founded on the theory of variation of parameters, and may be briefly described as follows :—

If we suppose for a moment that the disturbing function were reduced to a non-periodic term together with a single periodic term, the differential equations which give the variations of the 6 elliptic elements might be readily integrated, and those elements expressed in terms of the time and 6 arbitrary constants.

Now the relations found on this restricted supposition may be supposed to hold good in the actual case in which the disturbing function is composed of many terms, provided that the 6 quantities which were arbitrary constants are now supposed to become functions of the time.

M. Delaunay has shown that if these new quantities be introduced into the equations instead of the original elliptic elements, their differential coefficients with respect to the time may be found by means of equations exactly similar in form to those with which we started, provided a new disturbing function be employed which is found by transforming the original disturbing function after omitting the periodic term which was considered in obtaining the relation between the old and the new parameters. By a series of operations of this kind, M. Delaunay successively removes the more important periodic terms of the disturbing function, until the terms remaining are so small that the square of the disturbing forces may be neglected, in which case the parameters finally employed may be obtained in terms of the time by direct integration.

The co-ordinates of the Moon are known in terms of the elliptic elements, and therefore by transformation can be expressed in terms of the parameters by which those elements were replaced, and so by successive transformations those co-ordinates may be expressed in terms of the new systems of parameters, and finally in terms of the time.

The process of integrating the equations of the Moon's motion is thus broken up into a series of operations, each of which is comparatively simple in character, and the accuracy of which can be readily examined.

Astronomers all over the world will look forward with intense interest to the completion of this noble work.

On the Probable Retardation of the Velocity of Rotation of the Earth by the Action on the Tides.

The discussion on this most important question has been continued during the present year in a paper by the Astronomer Royal.

Treating the question as a hydrodynamical one, but confining his attention to an equatoreal belt of water, the Astronomer Royal has shown that, in this case, there would result a retardation of the velocity of the Earth's rotation as a necessary consequence of the lagging of the tides. The effect of great continental breaks is not considered. In the determination of the terms which produce the secular effects on the Earth's rotation, an assumption is made, that the position of an element of fluid at any time is independent of the initial position of that element. This simplifies the solution, but is in reality equivalent to assuming that no permanent currents can be produced in the fluid by the Moon's action. The same assumption is at the bottom of Delaunay's demonstration. A paper on this subject by Professor Sir W. Thomson appeared in the *Philosophical Magazine*, vol. xxxi. No. 212. The demonstration is essentially the same as Delaunay's. In this paper, however, some other causes are suggested as probably effective in producing a retardation of the Earth's rotation. In a note appended to the paper, Professor Thomson says: "It seems hopeless, without waiting for some centuries, to arrive at any approach to an exact determination of the amount of the actual retardation of the Earth's rotation by tidal friction, except by extension and accurate observations of the amount and times of the tides on the shores of continents and islands, in all seas, and much assistance from true dynamical theory, to estimate these elements all over the sea. But supposing these known for every part of the sea, the retardation of the Earth's rotation is easily calculated by quadratures."

In our *Monthly Notice* for May will be found an abstract of a paper by Mr. Ferrel, published so far back as 1853, in which it is insisted that a retardation of the Earth's rotation must be connected with observed phenomena of the tides. Mr. Ferrel's demonstration is essentially the same as Delaunay's. It must, we think, be admitted that the tidal friction must produce some retardation of the Earth's rotation; that we are here, in fact, dealing with a *vera causa*, but whether the whole of the outstanding quantity of lunar acceleration is due to this cause is perhaps still an open question.

Meteoric Astronomy.

No very remarkable additions have this year been made to our knowledge of the physical constitution and orbits of meteoric bodies beyond what has already appeared in the *Monthly Notices* of December last. The conviction, however, that henceforth their recurrence is to be regarded as a branch of Astronomical rather than of Meteorological inquiry has