ROYAL ASTRONOMICAL SOCIETY.

VOL. XIX. *February* 11, 1859. No. 4.

Rev. R. MAIN, M.A., in the Chair.

Francis Thos. Selby, Esq., Spalding;
Hamilton Field, Esq., Balham Hill;
Frank Robertson, Esq., Royal Crescent, Bath;
J. F. Cole, Esq., 1 Ashton Villas, Dalston; and
J. Collingwood Haile, Esq., Local Government Act Office,

were balloted for and duly elected Fellows of the Society.

Report of the Council to the Thirty-ninth Annual General Meeting of the Society.

The Council, in presenting the present Report, are again able to congratulate their constituents on the prospects of the Society, and of the science which it is intended to promote.

The Report of the Auditors, subjoined, will show the state of the finances:—

RECEIPTS.

	£	s.	d.
Balance of last year's account	290	18	6
By dividend on £1650 Consols	24	0	7
By ditto on £3500 new 3 per Cents	50	19	5
By ditto on £1700 Consols	24	19	5
By ditto on £109 8*s.* 5*d.*	1	12	9
By ditto on £3500 new 3 per Cents	51	8	2
Balance of Lee Fund	18	0	3
On account of arrears of contributions	100	10	0
156 contributions (1858–59)	327	12	0
4 compositions	84	0	0
16 admission-fees	33	12	0
13 first year's contributions	23	2	0
Sale of Publications	94	18	6
	£1125	13	7

EXPENDITURE.

	£	s.	d.	£	s.	d.
Salaries:—						
Mr. Grant, 1 year as Editor of the Society's Publications	60	0	0			
Mr. Williams, 1 year as Assistant-Secretary	100	0	0			
Ditto commission on collecting £569 15*s.* 6*d.*	28	10	0			
				188	10	0
Investments:—						
Investing £50 Consols				48	12	6
Taxes:—						
Land Tax, 1 year	5	7	6			
Income Tax, ditto	1	9	2			
				6	16	8
Bills:—						
G. Barclay, printer	330	12	11			
J. Basire, engraver	7	16	10			
Mr. Russell, engraver	22	8	8			
J. Rumfit, bookbinder	13	17	10			
Mr. De La Rue, maps	12	12	0			
Mr. Paunceforth, marking instruments	9	17	9			
Mr. Julyan, boxes for instruments	8	10	6			
Sundry payments out of Turnor Fund	14	13	7			
				420	10	1
Miscellaneous items:—						
Charges on books, and carriage of parcels	13	15	7			
Postage of letters and *Monthly Notices*	33	10	5			
Porter's and charwoman's work	26	8	2			
Tea, sugar, biscuits, &c. for evening meetings	13	13	0			
Coals, &c.	12	0	0			
Waiters attending meetings	3	17	0			
Sundry disbursements by the Treasurer	33	5	8			
Mrs. Jones, Lee Fund	8	3	9			
Banker's deductions on country cheques	0	2	0			
Error in casting	0	1	0			
				144	16	7
Balance at Banker's				316	7	9
				£1125	13	7

Assets and present property of the Society, Feb. 8, 1859:—

	£	s.	d.	£	s.	d.
Balance at Banker's				316	7	9
7 contributions of 2 years' standing	29	8	0			
20 ——— of 1 ditto	42	0	0			
Various sums on account of arrears	37	15	0			
				109	3	0
Due for publications of the Society				4	4	6

£1700 3 per Cent Consols.
£3500 new 3 per Cents.
£109 8*s.* 4*d.* (Lee Fund).
Unsold publications of the Society.
Various astronomical instruments, books, prints, &c.

Balance of Turnor Fund (included in Treasurer's account)				25	7	4

Stock of volumes of the *Memoirs*:—

Vol.	Total.	Vol.	Total.	Vol.	Total.
I. Part 1	29	VIII.	189	XIX.	228
I. Part 2	61	IX.	195	XX.	227
II. Part 1	99	X.	207	XXI. Part 1 (separate).	317
II. Part 2	54	XI.	220	XXI. Part 2 (separate).	100
III. Part 1	114	XII.	225	XXI. (together).	130
III. Part 2	133	XIII.	240		
IV. Part 1	134	XIV.	428	XXII.	225
IV. Part 2	146	XV.	214	XXIII.	226
V.	161	XVI.	236	XXIV.	242
VI.	180	XVII.	215	XXV.	252
VII.	203	XVIII.	217	XXVI.	277

Progress and present state of the Society:—

	Compounders.	Annual Contributors.	Non-residents.	Patroness, and Honorary.	Total Fellows.	Associates.	Grand Total.
February 1858 ...	155	184	40	5	384	52	436
Since elected	2	13	...	...	15	...	15
Deceased	−5	−6	−1	...	−12	...	−12
Resigned	...	−4	...	...	−4	...	−4
Removal	1	−1	...	5	...	...	...
February 1859 ...	153	186	39	5	383	52	435

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,
The *Wollaston* telescope,
The *Lee* 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 counterpoise stand; artificial horizon, with metallic roof; two tripod stands, one with table for artificial horizon.

17. Hassler's reflecting circle, by Troughton, with counterpoise 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.

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 *Beaufoy* clock, to the Rev. J. B. Reade.
The *Wollaston* telescope, to Mr. Rees.
The *Lee* circle, to Mr. Burr.
The *Herschelian* 7-foot reflector, to Messrs. Horne and Thornthwaite.

The *Sheepshanks* instrument,		No. 1, to Mr. Lassell.
Ditto	ditto	No. 2, to Mr. De La Rue.
Ditto	ditto	No. 3, to Mr. Carrington.
Ditto	ditto	No. 6, to Rev. J. Cape.
Ditto	ditto	No. 8, to Prof. Wheatstone.
Ditto	ditto	No. 10, to Sir J. Herschel.
Ditto	ditto	No. 19, to Mr. Dayman.

The other *Beaufoy* clock, the two invariable pendulums, and the brass quadrant (said to have been *Lacaille's*), reported for some years past as being in the possession of the Royal Society, but which could not be found by that Society, are still under inquiry, nothing definite having as yet been ascertained respecting them.

The Council have awarded the Medal to our Secretary, Mr. Carrington, for his *Catalogue of Stars*, from observations made at Redhill. Mr. Main will state the grounds of this award at a later period of the Meeting in the usual way. The Council think it right to add that the award of the Medal in two successive years to gentlemen who have been or are zealous and influential officers of the Society, has not been made without full knowledge of what may be said by those who have not examined for themselves the whole series of awards made since the commencement of the Society. But they further declare their conviction that the work now rewarded has a merit which it would be moral cowardice to pass over, for no other reason than that its author is employing time and talents in the service of the Society. And they rest quite assured that this will be the opinion of those who use Mr. Carrington's Catalogue at home and abroad.

At a special General Meeting, held on the 11th of last June, some alterations in the bye-laws were enacted, with which it is of importance that every Fellow should make himself well acquainted. The practice of submitting a list of Officers and Council for election, hitherto followed by the Council for convenience, is now enjoined by a bye-law. But, in addition to this list, any names forwarded by any two or more Fellows before the ordinary meeting of Council in December, are also to be submitted to the General Meeting in February; the common right of striking out any of these names and substituting others remaining unaltered. These lists are to be circulated as soon after the Meeting of Council in December as can be conveniently done. The effect of the change is that a much longer time is given for deliberation and concerted action; and any two Fellows now possess the power of making known their joint opinions as to the persons most fit to be the Officers and Council of the Society, without trouble or expense to themselves. This statement will account for the change of time and mode in the circulation of the balloting lists recently transmitted to all the Fellows. The details of this change will be found in the new edition of the Bye-laws recently published, together with some minor alterations which need not be noticed here.

In the Report of the Council to the last Annual Meeting it was remarked that the number and variety of the instruments presented to the Society by Miss Sheepshanks might be taken as evidence of the great attention bestowed by our late lamented Fellow upon the art of instrument-making generally. Some further particulars on this subject will not be uninteresting to members, many of whom were probably not so much acquainted with the nature of Mr. Sheepshanks' pursuits as to be able to appreciate fully the extent to which we are indebted to him for

improvements in the machinery so successfully employed of late in the various operations of practical astronomy.

We believe that Mr. Sheepshanks never undertook an uninterrupted series of observations of any particular class, his attention being directed principally to the examination of its means already at the command of the practical astronomer, and its improvement in future. Perhaps there is scarcely one of the many instruments that he possessed which did not undergo in his hands a systematic trial of its powers by application to some practical process which would subject those powers to a fair test; and in the course of operations of this description the defects and advantages of the several varieties of form were in most cases distinctly elucidated, and an improved construction was in many instances the result. Some contrivances, now considered almost indispensable to the astronomer, were, we believe, entirely his own; for example, the slipping-piece, so generally adopted as part of the apparatus applied to an equatoreal telescope employed in the measurement of small celestial arcs. And it was in the course of a long succession of experiments, undertaken with a view to the general object abovementioned, that he became the possessor of the many instruments which are now in the hands of the Society, and these derive therefore additional interest from the circumstances connected with them; from the just appreciation of their powers, which has been made in most instances, and from the improvements to which, in many, their examination led the way.

It must not, however, be inferred from the above remarks that any portion of the apparatus is in the present state of science unserviceable. Improvements there certainly have been; but as in some cases, in which it was possible, such improvements were introduced into these instruments themselves, and as they continued to be employed with success in many of the ordinary operations of practical astronomy by Mr. Sheepshanks himself, as well as by others, at whose disposal they were on various occasions placed, there is every reason to believe that in the hands of the Fellows of this Society they will yet do good service, and assist materially in the prosecution of the cause the advancement of which we all so earnestly desire.

The name of Richard Sheepshanks, so well known and so much respected in this Society, has been permanently connected with the University of Cambridge, and with his own college, by a splendid donation from his nearest representative. Ten thousand pounds Consols have been invested as the principal of a fund bearing the name of Sheepshanks, one-sixth part of which is to maintain an astronomical exhibition at Trinity College, while the remainder is to be devoted to the encouragement of astronomy in the University, under conditions which have been made public. The Council feel great pleasure in recording this noble tribute to the memory of an astronomer to whom this Society owes so much, and may reasonably hope that readers

of this Report, when the present generation has long passed away, will be reminded by these few sentences of useful labours and excellent results, for which the Sheepshanks fund shall have furnished the means. Nor can they omit to couple with this notice an allusion to another princely donation, of quite a different kind, made to the country not long ago by another member of our astronomer's family,—a family of many tastes, but of one spirit.

The twenty-seventh volume of the *Memoirs* is now all but ready for publication. It contains two papers by Mr. Cayley, which cannot fail to attract the attention of those who take an interest in the progress of physical astronomy. In the first of these papers the author has rigorously investigated the problem of disturbed motion, with especial reference to the circumstances depending on the variable plane of the disturbed orbit, and has deduced formulæ for the variation of the elliptic elements founded on his peculiar mode of treating the subject. In his second paper Mr. Cayley has exhibited an important application of his theory, by supplying a step which was wanting to Professor Hansen's Lunar Theory, in order that its results might be rendered readily comparable with those of other geometers.

In a short paper the Astronomer Royal has fully substantiated certain statements which he had made on a former occasion relative to Oltmann's calculations of ancient eclipses.

It is well known that the solar eclipse of March 15 was, in general, very imperfectly observed throughout England in consequence of the unfavourable state of the weather. At Cambridge, where the observers were rather more fortunate in this respect, some micrometrical measures were taken, which Professor Challis has employed in investigating the corrections applicable to the elements upon which the computations of the various circumstances relative to the eclipse depend. It appears from his researches that the line of central phase, as computed from Hansen's Lunar Tables, was situated a little to the north of the actual line, while on the other hand Burckhardt's Tables threw the line a little to the south of the position indicated by observation.

The series of communications in the volume concludes with a paper by Captain Clarke, "On the Reduction of Occultations of Stars by the Moon." By an elegant and simple process, the author has investigated the coefficients in the equations of condition for obtaining the small corrections applicable to the various elements upon which the time of an occultation depends. Observers of occultations will be enabled, by means of the results contained in this paper, to give a practical form to their labours with as little trouble of computation as the complexity of the subject can admit of.

The *Monthly Notices* continue to offer an easily accessible

channel of publication to observers and computers of all classes connected with the Society, while the importance of directing the attention of the Fellows from time to time to the labours of Astronomers in other countries has not been lost sight of. Since the last Anniversary it has been considered expedient to extend the distribution of this portion of the Society's publications to various individuals and Institutions, both at home and abroad, in addition to those whose names have hitherto appeared on the list for this purpose. At the same time, the successive numbers are now, in all cases, forwarded to their respective destinations as soon as they are received from the printer. The adoption of this practice will, no doubt, be attended with a small additional outlay on the score of postage, but the advantages derivable from an early circulation of the contents of each impression are obviously so great as amply to outweigh any considerations of this kind.

A plan has been carried into effect by which the *Monthly Notices* will become an integral part of the volumes of the *Memoirs*. All are aware that, for some years past, an octavo volume of *Monthly Notices* has always been given with each volume of *Memoirs* sold. It has been found that, by re-imposing the type of the *Monthly Notices* into a quarto form, with double columns, it is practicable to form an edition of the *Notices* which may be stitched up with the *Memoirs*, so as actually to form part of the volume. The expense of printing the annual report of each year twice will thus be avoided. It has sometimes been suggested that it was unnecessary to make the annual report a part of the volume of *Memoirs*, but those who have been students of old history have always protested against the omission. They have represented that it is a very serious defect of the older Transactions that they supply no materials for the histories of their several societies; from which it not unfrequently arises that the papers themselves are unaccompanied by information necessary to their being properly understood as historical monuments. Both ends are now made to meet; the annual report, and much current information besides, form a part of the very volume which contains the larger Memoirs; and the annual report is not printed twice. This saving, and other circumstances, will, it is hoped, enable the Council to carry into effect what every one wishes, namely, the gratuitous presentation of the *Memoirs* to all Fellows who make application for them.

Two fresh channels for the publication of astronomical intelligence and research have been opened during the year,—the additions to *M. Le Verrier's* daily *Bulletins* of the weather, and Dr. Brunnow's *Astronomical Notices*. In the first of these series, in which for the first time something like a general view of the daily meteorology of Europe is presented by the agency of the electric telegraph, and a first step taken towards out-

stripping the storm, by turning to the service of man one of its own elements; M. Le Verrier has taken advantage of its rapid dissemination by improved postal arrangements, to convey in all directions notices of discoveries, short ephemerides, and extracts from the valuable communications of his correspondents, many of which we may hope to see reprinted hereafter in a more permanent form. In the second, very recently started, Dr. Brunnow proposes to publish separately the researches and certain of the observations made at the Observatory of Ann Arbor in Michigan, now under his able direction. There may be need of both these channels of publication, and at present these may be early days for pronouncing an opinion on their ultimate advantage to astronomy; yet it may be remarked that the main feature of utility of such publications as the *Astronomische Nachrichten*, the *Astronomical Journal*, and our own *Monthly Notices*, is, that in their pages are *collected* together the shorter communications of observers, where, within moderate compass may now and hereafter be found the current astronomical literature of the time. If the practice of publishing in this manner should go beyond the cases in which distinct reason exists for anticipating the appearance of the *Nachrichten* and similar works, the secession, to give what would then be the appropriate name, would be rather an impediment than an assistance to those for whose use the new works are intended. Every additional subscription, moreover, is an increase of difficulty to the man of small means.

At Cambridge, the Lowndean Professorship, vacant by the lamented death of Dr. Peacock, has been conferred on Mr. Adams. By this very gratifying appointment, Mr. Adams is recalled to England from St. Andrews, in which university he has for a short time past held a professorship. The Lowndean Professorship was instituted about 110 years ago, as a combined professorship of astronomy and geometry—a term then synonymous with mathematics. The first three occupants were neither of them distinguished for the combination of the two kinds of knowledge; the fourth, Dr. Peacock, powerful in both, did not make their combination a pursuit. Mr. Adams, whose name is so remarkably connected with the application of mathematics to astronomy, has a claim to a chair thus named which no one can dispute.

The Council have to announce the loss by death* of the Dean of Ely; A. Baily, Esq.; Captain Bate; Edw. Bury, Esq., Lieut. Burdon; Rev. H. H. Jones; P. Kernan, Esq.; P. Legh, Esq.; Admiral Owen; H. L. Pattinson, Esq.; Lieut. Raper, R.N.; J. Reeves, Esq.; R. Taylor, Esq.

* Since this was read, the Council have received with deep regret the news of the death of our eminent transatlantic associate, W. Cranch Bond, on the 29th January.

ARTHUR BAILY was born about 1787, and died July 8, 1858. He was the younger brother of Francis Baily, whose name can never be mentioned in this Society without a word in remembrance of services which can never be too fully acknowledged. He was associated with his brother on the Stock Exchange, and continued in business long after his brother retired. Many years ago he was a frequent attendant at our Meetings.

Captain WILLIAM THORNTON BATE, R.N., was born in 1820; he became a Student at the Royal Naval College at Portsmouth in 1833, and remained there two years.

At school he had always shown a disposition for fun and hardihood, and amongst his companions at the Royal Naval College he was usually the leader in their various games and diversions; yet he was not the less distinguished in his studies, being endowed with great natural talents.

On leaving the Royal Naval College Mr. Bate was appointed midshipman to the Isis, the flagship of Rear-Admiral Warren, on the Cape of Good Hope and Coast of Africa station. He remained on this station for five years, where, in spite of every obstacle offered by a burning sun and unhealthy climate, he acquired those habits of activity and industry in the pursuit of his profession which enabled him to effect so much that was useful, and to gain such distinction in after-life. Mr. Bate was frequently selected for difficult service on boating expeditions. On one occasion, when his ship was sailing at a rapid rate in the Bight of Benin, a locality much infested by sharks, Bate jumped overboard without a moment's hesitation, and saved the life of a sailor who had fallen overboard.

In 1841, soon after war had been declared with China, Mr. Bate was appointed mate of H.M. Ship Blenheim; when he was actively employed in all the operations against Canton.

A detailed and well-written memoir of Captain Bate, by the Rev. John Baillie, has lately been published by Messrs. Longman, which contains so many characteristic traits of his disposition, and such a graphic account of his adventurous life, that we proceed to give some extracts from it.

"The Blenheim had been lying some weeks off Canton, when one morning all hands were ordered to 'prepare to assault the town.' Situated on a plain which is swept on two sides by the river, and having in the rear a considerable mountain called the White Cloud Mountain, the city was commanded by certain forts occupying some three or four slightly elevated hills immediately behind the town. The forts were occupied by Tartar troops, whilst the city itself, with its suburbs, containing a population of a million souls, was protected by a wall twenty-five feet thick at the base. Our own troops were a mere handful; but with the courage natural to Englishmen, the command was given to take the forts. The blue-jackets in-

stantly landed; and, almost in the twinkling of an eye, they were scaling the heights. Bate was among the first to mount the breach; and, just as he had reached the summit, he was struck below the chin by a ball. Instantly his whole chest was covered with blood, but the wound did not prove serious. The gallant fellow pushed on, pistol in hand, and the next moment his pistol was struck by another ball which cut it in two." (Memoir, p. 24.)

"The crisis was past. The 'braves' fled in precipitation, and the British force was in possession of the fort, since known as the 'Blue-jackets' Height.'

"Before the affair of Canton he had volunteered to Captain Collinson to be his assistant for the survey of the Chinese waters. The latter, having now obtained command of the Plover, at once secured Bate's services. 'His activity and energy,' writes Captain Collinson, 'were so conspicuous, that it was only by dint of great importunity that Sir Thomas Herbert, who had succeeded Sir F. Senhouse in the command of the Blenheim, consented to lose his services, permitting him to join my ship.'" (Memoir, p. 25.)

And thus he entered upon that special line of service in which he was to spend his remaining years with a distinction which placed him confessedly in the very front rank of his profession.

Mr. Bate was promoted to the rank of lieutenant in October 1841, for his gallantry in mounting the heights of Canton.

The war, however, was not yet ended; and wherever there was a post of danger there the young lieutenant was sure to be found.

"His ship had been despatched to the northern part of the Chusan Archipelago, to examine it preparatory to the movement of the fleet. On their arrival a party landed by two boats in a shallow creek, and had proceeded, with all but the boat-keepers, across a low level plain towards a small isolated hill, when leaving the others at the foot, Bate and Collinson went to the summit to look around. 'Suddenly,' writes the latter, 'I perceived him to run forward, at the same time drawing his sword; and I soon found he was chasing a Chinaman, who with sword and shield had been ensconced on the summit watching our proceedings. A horrid shout, however, distracted our attention from the individual; and on looking on the plain below we found the Chinese army drawn up in array to receive us. Nothing remained but a sharp retreat to the boats, from which we should have been cut off had it not been for the determined face which Bate, in command of the rear, maintained; keeping them in check by a cool, well-directed fire.'

"The next morning, twenty-five in number, they went on shore; and, in the course of forty minutes, without a single casualty, dispersed the Chinese forces, killing their leader and twenty others, capturing their military chest, and setting fire

to their junks. 'This success,' Captain Collinson adds, 'was mainly owing to the prompt manner in which Hall and Bate led their men along the plain.'

"Some weeks elapsed and another illustrative incident presented itself. It was at the assault at Chapoo. 'To the Plover,' writes Captain Collinson, 'was assigned the office of covering the landing of the troops; and, on Sir H. Gough leaving the beach, he accepted my tender of Lieutenant Bate's services as his aide-de-camp to keep up communication with the rear. Among the outward defences of the city were several horseshoe-shaped enclosures, whence the Chinese maintained a harassing fire. Supported by two men Bate made a rush at one of the enclosures, and was at once involved in a hand-to-hand conflict with the officer commanding it—a blue-button mandarin. In the course of the struggle both parties fell to the ground, but Bate by his superior agility remained uppermost, and succeeded in disarming his antagonist and in making him prisoner.

"A few minutes later a fresh achievement meets us. The troops were now at the gates of the city, but without any battering-train or field-piece to force them open. The commander, apprehensive that the Chinese might rally before any men could be brought to the front, was looking round on every side with anxiety, not knowing what to do, when, suddenly, Bate was seen sword in hand scaling the wall alone. The next moment he was on the summit; the Chinese, supposing him to be the leader of a party, precipitately abandoned the post; and the brave fellow, coolly descending on the other side, opened the gates to the troops. It seemed as if he bore a charmed life." (Memoir, p. 33.)

In the spring of 1846 Bate returned as the Plover's senior lieutenant to England.

Lieutenant Bate was not immediately employed in active service, he profited by this leisure to pursue professional studies, first at the Steam Factory at Woolwich and afterwards at the Royal Naval College.

He was promoted to the rank of Commander in Feb. 1848, and soon afterwards appointed to command the Royalist, and resume the survey in the Chinese waters.

Bate was most usefully engaged during the ensuing five years in surveying operations; his industry knew no bounds: as a specimen of his labour and skill it may be mentioned that he executed an elaborate hydrographic survey of the island of Palawan, three hundred miles long, with its harbours and adjacent waters, fixing all the mountains and prominent hills visible from the sea.

Commander Bate naturally anticipated being promoted on his return to England after all these services, but in this he was disappointed, and the Admiralty sent him once more to the China station, in command of a small brig, the Bittern; and it was not until August 1856 that he obtained the command of the

Actæon, a much larger and finer ship, in which he continued his surveys, and was also engaged in active warlike operations.

In consequence of Yeh, the Chinese Imperial Commissioner, having refused full satisfaction for an insult offered to the British flag, it was resolved upon by our commander to seize the defences of the city of Canton.

In these operations Bate bore a very conspicuous part; the Admiral, Sir Michael Seymour, writes with respect to the storming of the defences of Canton, "The way was most gallantly shown by Commander Bate, whom I observed alone waving an ensign on the top of the breach."

Just at this period the intelligence of Bate's being promoted to the rank of Captain reached him. Captain Bate distinguished himself in command of the Macao-fort, which he held with three hundred men against all the attacks of the Chinese after the ships had retired lower down the Canton river.

On the 28th December, 1857, Captain Bate wrote thus on board the Actæon: "'We opened our fire at daybreak. I am just going off with the Admiral to the landing-place, which is about two miles to the eastward of the city. We stop out all night and advance early in the morning.'

"At daylight the following morning the 'rocket-practice' gave place to a steady fire from a mortar-battery; and Bate's little party, now joined by the general and his staff, proceeded in the direction of the city wall.

"In a hasty reconnoitre they found, some dozen yards in advance, a ditch or gorge forty or fifty yards broad. In the intervening space was a low earthen fence, surmounted by bunches of high reeds, which interrupted the view of the spot where the scaling-ladders were to be placed to mount the broken embrasure. All around hurtled a storm of balls and rockets from the wall; and no one could cross to the edge of the ditch without imminent danger. Yet some one must run the gauntlet, if the ladders were to be set for the escalade.

"Captain Bate at once volunteered to go—as he rushed across the open patch, to look into the ditch, all eyes followed him, and more than one heart throbbed.

"'Our Captain,' says his coxswain, who was at his side, 'was in the act of taking the distance from the ground to the top of the wall with his sextant, when a shot from a gingall struck him in the right breast. He fell straight on the ground and never moved afterwards.'" (Memoir, p. 240.)

In half-an-hour he had ceased to breathe. And thus died one of the most promising officers in the Royal Navy, esteemed and regretted by all. His piety was most fervent and unpretending, his courage and professional skill beyond all praise. Captain W. T. Bate was only in his seven-and-thirtieth year when he was killed before the walls of Canton.

Capt. W. T. Bate was elected F.R.A.S., 9th March, 1849.

Commander WILLIAM BURDON, R.N., entered the naval service in 1841, he was made Lieutenant in 1848 and promoted to the rank of Commander in Dec. 1852, on the East India Station. Elected F.R.A.S. in May 1852.

He returned to England in a weakly state, and died at Sydenham in November 1857, aged thirty-two years.

The Rev. H. H. JONES was born at Brownsover, near Rugby, on the 6th of June, 1787. After completing the usual course of studies at Rugby he entered himself at Bristol College, and studied for the Baptist ministry under Dr. Ryland. On leaving the college he officiated for some time in the congregation where the Rev. John Foster, the celebrated essayist, was minister; and subsequently he became the co-pastor with the Rev. W. Morgan, at the Baptist Chapel, Birmingham. In 1821 he removed to Tamworth, where he continued in charge of a congregation for about two years. In 1823 the late Mr. Samuel Greg having built, at his own cost, a chapel for the work-people employed at his manufactories at Styal, in Cheshire, allowed them the privilege of selecting their own minister. Several persons of different denominations were accordingly invited and officiated in succession; but the choice of the congregation fell upon Mr. Jones, and he remained as their pastor for upwards of ten years. During 1833 he was elected Registrar and Chaplain of the Rusholme Road Cemetery, Manchester, which office he retained up to the time of his unexpected death, on the 21st December last.

Mr. Jones became a Member of the Manchester Literary and Philosophical Society in 1846, and officiated as one of its Honorary Secretaries for several years. He became a Fellow of the Astronomical Society in 1848. For many years he prepared the astronomical portions of the Manchester Almanacs, and was regarded both as a careful observer and a delicate manipulator. For the last few years he held the appointment of Astronomer to the Manchester Corporation, who provided him with a good transit instrument, &c., fitted up in a small observatory adjoining his house. He was thus enabled to regulate the public clocks in Manchester, and succeeded in keeping that in the vestibule of the Town Hall correct to a degree unknown before. The pendulum rod of his sidereal clock was of his own contrivance, and withstood the variations of heat and cold very satisfactorily. The pendulum itself was regulated by means of a small cup attached to the rod, into which were placed a few small shot, which were increased or decreased in number, according as the clock went too slowly or too fast. This could be done without stopping the clock. He also introduced some improvements into the apparatus for illustrating M. Foucault's experiments for proving the rotation of the earth, at the time when these were repeated by him before his friends in Manchester.

The literary and scientific papers by Mr. Jones are not numerous; but he read many papers before the Manchester Society which have never been published. In 1837 he published an essay on the *Philosophy of Education*, which was republished with additions in 1857. The lapse of twenty years between the first and second issues had not impaired its value, since it contains an excellent *resumé* of the leading principles of education. The tenth volume of the new series of the *Manchester Memoirs* also contains a Biographical Notice of Peter Clare, Esq. F.R.A.S., from his pen; and in the fourteenth volume he offers a few Remarks on the Occultation of *Jupiter* and his Satellites by the Moon, January 2, 1857. Among his unpublished papers may be noticed those On the Determination of the Distance of the Fixed Stars from the Sun, and a most elaborate one On the truth of the Nebular Hypothesis.

Peter Legh, of Norbury Booths Hall, near Knutsford, Cheshire, was descended from an ancient family in the county of Cheshire, where he was possessed of a fine ancestral estate.

He was the author of a work entitled the *Music of the Eye, or Essays on the Vitruvian Analysis of Architecture*, 1831, 8vo.; and the profits of the work, if any, were to go towards a fund for building a church at or near Torkington, in the parish of Stockport, Cheshire.

A few years before his death Mr. Legh commenced the building of a church at a very considerable expense, in a village near his mansion, which was completed in or about 1857. He published an Ombrological Almanac, of which the seventeenth number appeared in 1856.

He was an excellent scholar, an accomplished man, and an amiable, benevolent, and liberal friend. He was fond of painting, and the possessor of some fine works of the ancient masters and an extensive library. He was also a skilful mechanic and fond of turning.

He is perhaps best known by his Ombrological, or as others would call it meteorological, Almanac. He had a strong opinion of the possibility of arriving at a knowledge of the laws of the weather; and he claimed to have had some success in his own investigations. We fear that no palm can be awarded to him in this most tangled of all subjects; but he has the praise of great diligence, as well as of good temper, in maintaining that most difficult position of a speculator who stands alone in his conclusions.

Vice-Admiral William Fitzwilliam Owen, born in 1773, at Manchester, was the son of Captain William Owen, who, after losing an arm in the service of his country, was accidentally killed at Madras in 1778. Fitzwilliam was the younger brother of the late distinguished Admiral Sir Edward Owen, G.C.B., and was educated with him at the celebrated

Hanway School at Chelsea. After attaining the first rank in that seminary, he entered the Royal Navy in the summer of 1788, on board the Culloden, of 74 guns, commanded by his relation, Sir Thomas Rich. By this officer he was from time to time placed in several ships for the purpose of acquiring knowledge in his profession; but he rejoined the Culloden in time to be present at the great battle fought on the 1st of June, 1794.

Shortly after that glorious conflict, Mr. Owen sailed in the Ruby, 64, for the Cape of Good Hope, where he was present at the capture of a Dutch squadron of three sail of the line and six frigates and sloops, in Saldanha Bay, in August 1796. Returning to England after this exploit, he joined the London, 98, bearing the flag of Admiral Colpoys, with whom he quitted that ship during the alarming mutiny at Spithead, in May 1797; for his firm conduct on that trying occasion he was promoted in the following month to the rank of Lieutenant, and at the same time placed in command of the Flamer gun-brig. In this and other ships and vessels he experienced much active Channel service, till the close of the first French revolutionary war.

At the recommencement of hostilities, Owen was among the foremost to tender his services, in consequence of which, in July 1803, he was appointed to command the Sea-flower, a brig of 14 guns, in which he shortly afterwards sailed for the East Indies; on which station he was employed on various missions by the Commander-in-Chief. In 1806 he captured Le Charle, a mischievous French ketch, and explored several of the channels between the Eastern Islands, to the great improvement of the charts. Towards the close of that year he piloted Sir Edward Pellew's squadron through an intricate navigation into Batavia Roads. Here his bravery and skill were conspicuous in the command of a division of armed boats at a successful attack on a Dutch frigate, seven man-of-war brigs, and about twenty armed vessels, for which he obtained a very honourable mention in the Gazette. In the following year he contributed to the capture and destruction of the dockyard and stores of Griessik, in Java, together with all the men-of-war remaining to Holland in India, consisting of the Revolution, Pluto, and Kortenaar, of 70 guns each, with the Rustoff frigate and a flotilla of gun-boats.

In 1808, Lieut. Owen had the misfortune of being forced to surrender the useful little Sea-flower to a couple of French frigates, in the Bay of Bengal. The brig was soon retaken and commissioned by Lieut. George Steward; but Owen was carried prisoner to the Isle of France, where he was detained till June 1810, when he was exchanged. When preparing to depart, he playfully told the French Governor that perhaps they might soon meet again; at which General De Caen laughed — albeit not often in that mood — and hoped that he

would be brought to Port Louis in a vessel more worthy of capture than his last was. The *badinage* was rather predictive of coming events.

Meantime, Owen had been made a Commander, by a commission dated in May 1809; and, on his return to India, was occupied in assisting the authorities at Madras with his opinions, and in superintending the transports for the expedition against the Isle of France.

Our officer's next appointment was to the Barracouta, an 18-gun sloop-of-war, which he joined in time for assisting at the blockade of Batavia, previously to the invasion of Java. On the arrival of the forces under General Sir Samuel Auchmuty and Commodore Broughton, he assisted in the debarkation of the troops at Chillingching; and continued attached to the army until after the surrender of Batavia, in August 1811. He had been advanced to post rank in May of the same year, and after acting in command of the Piedmontaise a short time, he was appointed Captain of the Cornelia, of 32 guns. In this frigate he sailed from Batavia Roads in March 1812, with a small squadron, consisting of the Phœnix, Bucephalus, and other vessels under his orders, with detachments of the 59th and 89th regiments on board, to take possession of the commercial depôt at the mouth of the Palembang river, at the eastern end of Sumatra. Having achieved this object, he returned to England in charge of a convoy from China, in June 1813.

Having paid unceasing attention to the Hydrography of the East during his cruises, Captain Owen now rendered very material assistance to his friend, the late Captain Horsburgh, in the compilation of his well-known *Oriental Navigator;* and he moreover employed his half-pay leisure in correcting charts, and in making a translation of Franzini's *Sailing Directions* from the Portuguese. At length, in March 1815, he was appointed to the Surveying Service on the Lakes of Canada, where he opened the line of operations which has since been so ably completed by his *élève*, the present Rear-Admiral Bayfield. In August 1821 he was appointed to the Leven, 24, in which corvette, with the Barracouta, he was for upwards of four years employed in an examination of the west and east coasts of Africa,—an arduous duty carried on in the face of malignant fevers and deadly cusualties. In the Ashantee war he was able to render an effective co-operation to General Turner, as was acknowledged by the latter in the London Gazette.

On his return from this mission, Captain Owen's representation was so strong that the island of Fernando Po, in the Bight of Benin, would not only prove more healthy than Sierra Leone, but would also afford greater facilities for the suppression of the slave-trade, that he was commissioned, in February 1827, to the Eden, of 26 guns, for the purpose of forming a settlement there, and completing his surveys. On

this he was occupied till the close of 1831, when he retired to half-pay, but not to idleness, for his charts, remark books, and attention to improving the means of maritime surveying, fully employed his time. In this Society he worked on our Council; and he presented us with two specimens of his professional ingenuity in a Double Reflecting Circle and a Quadruple Reflecting Sextant.

The island of Campo Bello, in Passamaquoddy Bay, New Brunswick, which belonged to the Owen family, had descended to the subject of our notice and his brother; and as William evinced a desire to settle there, Sir Edward surrendered his portion to him. Here he had full occupation for a time in getting it into order, and in establishing his family, consisting of a wife and two daughters. Soon after his arrival he was elected member for that locality in the House of Assembly at Fredericton, where he brought various abuses to light, and involved himself in the cares of a staunch reformer. As he was still zealous in the cause of hydrography, Sir Francis Beaufort procured an appointment for him to a fine steam-vessel, the Columbia, of 100-horse power, to survey the Bay of Fundy and and the coast of Nova Scotia. Being superseded on his promotion to flag rank in December 1847, he continued the rest of his life on half-pay.

In conduct and bearing our excellent Admiral was at once firm and kind, shrewdly sensible and unostentatious, with a manner bordering on the eccentric; on service he was authoritative without being at all tyrannical, a man of ready resources and unremitting zeal. In speech he was fluent and blunt. When a ministerial peer once made him a proposal which he considered as not quite proper, he replied, "My Lord, I may be poor, but still I am proud." On the Admiralty forwarding him a complaint which they had received from the Marquis Palmella relative to some differences at Mozambique, he closed his explanation with — he "trusted that the word of a Captain in the British Navy was as good as that of a Portuguese Marquis." He built a church at Campo Bello, which he endowed, and after considerable trouble prevailed on the provincial bishop to appoint a clergyman of the Church of England to it. This gentleman regularly officiated, until one Sunday the Admiral gave him notice that he wished to occupy the pulpit himself that day! So singular and abrupt a hint led to an altercation, and as Owen declared that he would take possession if necessary by force, the clergyman resigned the living, and the Admiral for a time regularly performed the clerical duties — the congregation attending even more regularly than before.

Vice-Admiral Owen, whose faculties had been declining for some time, died at St. John's, New Brunswick, on the 3d of November, 1857, at the advanced age of eighty-four years. He had been very long a Fellow of the Society, which he regularly

attended when in town; and he was for some time on the Council.

HUGH LEE PATTINSON was born and educated at Alston, in Cumberland, where his parents, belonging to the smaller landholders of that locality, had for generations resided.

A lecture on chemistry, which he accidentally heard, awakened his attention to that science, and to it he devoted all his spare time. When still very young he removed to Newcastle, having obtained a situation in an extensive soap-manufactory. At about the age of thirty he returned to Alston, having, on the recommendation of Mr. John Taylor of London, been appointed Assay-Master at the extensive lead-mines of the Commissioners of Greenwich Hospital.

While thus engaged Mr. Pattinson made a discovery which connects his name in a distinguished manner with metallurgic science. Previous to this discovery the silver originally contained in lead ore was obtained by the conversion of the whole of the lead into litharge, leaving the pure silver behind; the litharge had to be reconverted into lead, at considerable expense and with considerable loss of metal. After an immense number of unsuccessful attempts to effect the separation by a less circuitous method, Mr. Pattinson discovered that a mixture containing only a very few ounces of silver to the ton of lead, in cooling appeared to resolve itself into two portions, one remaining fluid after the other had assumed a solid and granular condition. These granular crystals were found to consist of lead nearly free from silver; the silver alloy remaining being fusible at a lower temperature than pure lead. Three or four years passed away before all the difficulties attendant on the application of this discovery were overcome, but all these gave way before his ingenuity and perseverance. Prior to the discovery of the *Pattinson process*, as it is called, the extraction of silver from lead could only be pursued with profit when present in the proportion of 20 ounces to the ton. The minimum was now reduced to 3 ounces, and lead-mines, before neglected, could now be worked with advancement.

Mr. Pattinson was one of the principal founders of the extensive chemical works at Felling and Washington near Newcastle-on-Tyne.

From an early age mineralogy and geology, also electricity and magnetism, received a considerable share of his attention, and he occasionally favoured his neighbours with lectures on scientific subjects. Every one is now familiar with "Armstrong's Hydro-Electro Machine." It was Mr. Pattinson who first brought before the public the phenomenon which, presenting itself at a steam-boiler at Cramlington Colliery, gave birth to that machine.

For many years before his death he derived considerable pleasure from the pursuit of practical astronomy. Mr. Pattinson

was one of the first and warmest admirers of the optical productions of Mr. Cooke of York. From him he procured the largest object-glass that Mr. Cooke had up to that time produced, $7\frac{1}{4}$ inches aperture, which was mounted equatoreally with graduated circles, clock motion, micrometer, &c., and more than realised Mr. Pattinson's most sanguine expectations. The equatoreal was erected in a neat observatory, near his residence at Scots House, which was also furnished with two clocks, chronometer, and a transit instrument formerly belonging to the late Francis Baily. The large equatoreal was lent to Prof. Smyth for his scientific expedition to Teneriffe, in which Mr. Pattinson took a warm interest. More than one 2-foot disk of glass was examined with a view to still larger results, but the optician reported "bad glass."

A slight digression may perhaps be pardoned to couple the names of two of our deceased Fellows in a manner alike creditable to both. The last night the writer spent with him at Scots House, a few months before his death, Mr. Pattinson spoke in glowing terms of approbation of Dr. Peacock's valuable treatise on algebra then on the library table. His leisure hours for some time previously had been spent in reading the more advanced portions of the second volume. Teacher and student died at nearly the same time, their names stood together on our alphabetical list of Fellows, and at the same anniversary their obituaries stand side by side.

In private life Mr. Pattinson was most kind and courteous. He was very liberal in his public subscriptions and private charities. He had a rich fund of anecdote, and a genial, humorous manner in conversation. He died on the 11th of November, in the sixty-second year of his age.

George Peacock was born at Denton, near Darlington, April 9, 1781. His father, Thomas Peacock, was a clergyman and schoolmaster at that place, and was the author of a manual of arithmetic, *The Tutor's Assistant Modernised*, which went through several editions, and also of a work on mensuration, *The Practical Measurer*. Both works were first published about 1810. The son finished his education under the Rev. James Tate, at Richmond, whom he always entertained the highest regard for, and to whom he dedicated the first of his works on algebra in most affectionate terms. He then removed to Trinity College, Cambridge, and took the degree of B.A. in 1813 with high distinction, being second on the list of wranglers, and second only to Sir John Herschel. A fellowship, and ultimately a tutorship, followed of course; and about 1817 he took orders. Of his works we shall presently speak separately. He continued to teach in Trinity College till 1839, when he was made Dean of Ely; and thus removed from a college life when he was close on fifty years of age, he entered on his second career without difficulty from its novelty

or hindrance from his previous habits. Once a dean, says one of the journals, he grasped and carried out all that a dean's life ought to be. The restoration of his cathedral, and the purification of the town, are among the successes which prove at once the goodness of his judgment, and the power which talent, judgment, and character united, gave him over the minds of others. His clerical duties were varied by those of the Lowndean Professorship, to which he was appointed in 1836, by the Standard Scale Commissions (1838, 1843), by the Cambridge Commissions (1850, 1858), by the Prolocutorship of Convocation (1841–47, 1852–57), and by various minor duties. Whenever a man of safe judgment was wanted, who united kindness and courtesy to a clear view of duty and a firm purpose, the government, the clergy, and the university, knew where to find him. In the midst of heavy duties, he died Nov. 8, 1858, of bronchitis. He had for many years suffered under bad health, to the frequent interruption of his scientific undertakings. In 1847 he married the sister of Bishop Selwyn. His own father and mother lived to extreme old age, and saw their son in his highest honours. A full detail of his life is given in the Notices of the Royal Society, drawn up, it is believed, by the only person who would omit to name his superior on the Tripos. That one of these men should pay this last tribute to the other was rendered most fitting as well by their early struggle, as by their subsequent association in forwarding many a useful undertaking.

Dr. Peacock had cultivated the Continental analysis, then very little known in England, at an early period of his studies. Professor Woodhouse, in 1803, had called attention to the foreign mathematics, as they were called, in his *Principles of Analytical Calculation*,—a work which was no doubt intended to recommend the change which afterwards followed, but was written by a man who saw that a severe examination and a discriminating criticism would better advance the object than the eulogium of a partisan. In 1813, there were found in the University a few very young men who had fully mastered the Continental system. Among these were Messrs. Peacock, Babbage, Herschel, and Maule (afterwards Justice). Peacock was distinguished by very extensive reading: his power in this respect was a talent, and a rare one; for when no duty compels, and books are not to be encountered as drudgery, none can bring themselves to face volumes by the hundred except those in whom the memory and the reflective power are so strong that every page is suggestive of comparisons. The young men alluded to formed an Analytical Society, which produced a small volume of Memoirs in 1813; and they proceeded to declare open war upon the studies of the University. A translation of Lacroix's *Differential Calculus* was prepared (1816), and a volume of examples to accompany it (1820); in the latter Mr. Peacock had the largest part. In 1817 he was

Moderator, and in this capacity he ventured to introduce the new system into the public examinations, his colleague retaining the old one. This old system made its appearance once more in 1818; in 1819 Mr. Peacock was Moderator, with a colleague of his own sentiments (Mr. Gwatkin), and the change was fully accomplished. All the chief actors in producing it have lived to see their work fully done, and their country in full communication with all the world after more than a century of nearly complete exclusion. Mr. Peacock subsequently published an anonymous Syllabus of Trigonometry and Algebraic Geometry, which was much wanted in the University; indeed the reformers had kept their eye too exclusively upon the differential calculus, of which this publication was a kind of confession.

In 1826 he published in the *Encyclopædia Metropolitana* his historical article on Arithmetic, by far the most learned article of the kind which exists: for though Chasles and others have written able and minute dissertations on individual points, there is nothing like a treatment of the whole subject, except the article of which we now speak, which treats details with accurate minuteness, and gives an amount of information which would have been thought impossible within the space. This finished work was not undertaken until the publication of the *Encyclopædia* suggested it: and it was among the earliest appearances of the work.

In 1830 appeared the first of his two works on Algebra, which are not to be called first and second editions of one work. The difficulties under which algebra had laboured as to the interpretation of some of its most essential symbols had begun to receive something like a solution; but it was rather a clear glimpse of what was to come than a full attainment. There was much need of a philosophical mind which should make the first principles of algebra coextensive with the conclusions founded upon them. Mr. Peacock meditated long upon this subject, and produced the first finished effort towards a *theory of algebra*. He was much assisted by the details which had been published by Argand, Mourey, Buée, and Warren,—writers who were all, more or less, possessed by the idea that they were constructing a new algebra, when, in truth, as was first fully seen by Peacock, they were explaining the old algebra. The next work on Algebra (two volumes, 1842 and 1845) is a systematic separation of universal arithmetic, or the science of numbers under general symbols, from that higher interpretation of symbols which alone is properly called algebra. The first volume is most admirably fitted to be the introduction of young students into the whole subject of symbolic language.

Between these two works Dr. Peacock presented to the British Association, in 1834, a report 'On the Recent Progress of Analysis.' This is a critical investigation of those higher difficulties which meet the student when he carries algebra into the differential calculus. It abounds with cases which are still

matters of opinion; but there are very few mathematicians who venture into full discussion of these difficulties, in the elucidation of which lies all our hope of future progress. Many a young analyst will owe his strength to his acquaintance with this vast thinking ground, in which a mind long accustomed to comparison has brought before him at one view the details which, singly and apart, present only difficulty without suggestion of the direction in which to look for light.

The Life of Dr. Young, with the edition of his miscellaneous works (in which he was assisted as to the hieroglyphical portion by Mr. Leitch), occupied Dr. Peacock for many years. The life itself is a very good specimen of judicious biography and of biographical research; while the knowledge to edit the miscellanies of so varied a writer as Young is possessed by very few. Of Peacock it may truly be said that he placed Young's statue on its pedestal.

His observations on the University Statutes, published in 1841, showed that he had deeply studied the University in which he was brought up, and was as ready to aid in corporate amelioration as in improvement of mathematics.

Dr. Peacock's last writing was a series of short answers to the questions on the Decimal Coinage proposed by Lord Overstone, one of her Majesty's Commissioners on the subject. Dr. Peacock was a strong advocate for this change in the coinage: and he had gone deeply into the question, both as an historian of arithmetic, and as a member of the Standard Scale Commissions.

He was one of the earliest members of our Society, though his residence at Cambridge and Ely prevented him from being a frequent attendant. To this short sketch of his labours the Council may add that any sketch, however short, supersedes the necessity of any description of character. One thing may well be added. A man may have been all that Peacock was, and have done all that Peacock did, without possessing that gentleness of nature, kindliness of feeling, courtesy of manners, and benevolence of action, which endeared him to all who came in contact with him.

Lieutenant Henry Raper, R. N., was the eldest son of the late Admiral Raper, an officer of much distinction in the naval service, and who was signal lieutenant to Lord Howe in the action of the 1st June, 1794.

Henry Raper's education was commenced at the Charter House School. He entered the navy as volunteer on board the Mars (74), commanded by his father, in 1811, and, in March 1812, became a student at the Royal Naval College, Portsmouth. During the two years and a half which Mr. Raper remained there, he was remarkable for talent and application, as well as for great steadiness and regularity, which, together with extreme amiability, were his distinguishing characteristics throughout life. He early evinced a talent for mathematics,

and received a silver medal at the Royal Naval College examination, in 1814, for his proficiency in that science.

Having gone through the course of instruction at the Royal Naval College with credit, he was appointed to the Nymphen frigate, employed on Channel service, in April 1815; and in October of the same year sent as midshipman on board the Alceste (38), Captain Sir Murray Maxwell, which ship was fitting out to convey the Earl of Amherst as ambassador to China.

The Alceste conveyed the ambassador to his destination in safety, but on her homeward voyage was wrecked in the Straits of Gaspar, in February 1817, when the subject of this notice bore his full share of the hardships experienced by the crew, who, from their forlorn condition on the rocky islet on which the Alceste was wrecked, were in danger of death from thirst, and threatened by large numbers of pirates, whose vessels assembled around in the hope of destroying all the ship's company, and thus obtaining valuable plunder. The Alceste's crew were relieved from this critical situation by vessels sent from Java.

Mr. Raper was next appointed midshipman to the Tyne (26), Captain Gordon Falcon, an officer of talent, who was deemed a remarkably good seaman and navigator. The Tyne was employed three years on the South American station, where Mr. Raper profited by the opportunity of improving his knowledge of nautical matters.

On the return of H. M. ship Tyne to England, in 1820, he was appointed to the Seringapatam, Captain Samuel Warren, in which frigate he served two years as midshipman, chiefly on the home and Mediterranean stations.

In 1822, he was appointed midshipman of H. M. ship Adventure, commanded by Captain W. H. Smyth, employed on surveying service in the Mediterranean, and was, indeed, extremely well qualified for such an appointment by his talents, his taste, and his previous services. Under the eye of the accomplished, scientific captain of the Adventure, Mr. Raper gained a very perfect knowledge of seamanship and navigation.

Admiral W. H. Smyth states, that "Admiral Raper was most anxious that his son Henry should join the Adventure; but in consequence of that ship being employed on the Egyptian coast, it was not till the spring of 1822 that he was able to get on board. On becoming acquainted with his peculiar bent in nautical studies, I placed him in charge of the chronometers, with his former college associate, the late unfortunate Captain Graves. In our next surveying cruise, along the shores of Tunis and the Lesser Syrtis, he proved himself very zealous in the acquirement of a fuller acquaintance with nautical science, and he won my high opinion of his zeal. In giving him certain directions one day, amongst the ruins of Carthage, of which he was about to draw a plan, I remarked to him

that we had not had a really good book on navigation since Robertson's *Elements*, ending with,—'And, Raper, if ever you get upon half-pay, such a work, with all the recent appliances and resources, will be a capital employment for your leisure time.' All the auditors laughed; but I am inclined to think that even then he plotted his most useful work, *The Practice of Navigation*."

Raper was next appointed to the Rochford, the flag-ship of Admiral Sir Graham Moore, in command of the Mediterranean fleet, with a view to his promotion; and in July 1823, he was promoted to the rank of lieutenant on board the Euryalus. He afterwards joined H. M. ship Dispatch, in which ship he remained until she was paid off in 1824.

Not being employed on active service in his profession, Lieutenant Raper assiduously studied the higher branches of the mathematics. He was selected by the Board of Admiralty, in December 1832, with other scientific persons, to form a committee to improve the method of measuring the tonnage of ships.

In 1840, Lieutenant Raper published his *Practice of Navigation*. This may be regarded as a very spirited undertaking, considering that there were already three or four very excellent treatises on that subject, whose well-earned reputation had rendered their titles and their methods of working problems so familiar to all naval men, that anything novel was unlikely to be adopted. Notwithstanding this, the work was so much approved of that it speedily came into general use.

The Royal Geographical Society bestowed a Gold Medal on Lieutenant Raper, in 1841, for this book. The Directors of the East India Company also ordered copies of the work to be supplied to the ships of their navy; and in January 1843, the Lords of the Admiralty directed that a copy of *The Practice of Navigation* should be supplied to each of her Majesty's ships —which is a high and unusual distinction.

Owing to the aid constantly afforded to Lieutenant Raper by the Hydrographic Department of the Admiralty, the Table of Maritime Positions forms a very valuable portion of this work, it being esteemed quite equal, if not superior in correctness, to any that has hitherto been published.

Lieutenant Raper became a Fellow of the Royal Astronomical Society in November 1829. He was for many years on the Council, during several of which he filled the post of Secretary. While thus engaged, he was diligently employed upon the higher mathematics, in pursuance of a plan, which he did not live to complete, of publishing a second volume of the *Navigation*, which should contain attempts at the highest theoretical discussion of all the mechanical questions which interest the scientific seaman, beginning from the time when the ship's keel is laid down. For several years Lieutenant Raper devoted his chief attention to the composition of this

Treatise, but in its progress the manuscript extended, and the work assumed the form of a scientific Treatise on various branches of Astronomy, Mechanics, and Physics, rather than an isolated application. It is to be feared that these writings of Lieutenant Raper's (who was at once so practical and so scientific in his ideas) were not left in a state by which their publication is rendered likely.

It is worthy of notice that Mr. Raper excelled in a peculiar kind of satirical writing, which, without being offensive to individuals, was very effective. There are various anonymous criticisms on nautical proceedings and projects, of which a person who knew the author of one could not help knowing the author of the rest.

In November, 1850, Mr. Raper married a daughter of the Rev. Frederick Ekins, rector of Morpeth, Northumberland. This notice of the life of our lamented Fellow and friend would be incomplete were we not to mention that, thus blessed with a happy home and a companion of kindred pursuits, Raper, although suffering severely during the last eighteen months of his life from rheumatism and neuralgia, continued his labours to the very last days of his existence. Shortly before his death, he sent a communication to the Royal Astronomical Society on "An Improvement in clearing the Lunar Distance;" and he was able to work on his manuscripts until a day or two of his death.

He had been ordered to Torquay by his physician, and died there on the 6th January, 1859, in his sixtieth year.

Richard Taylor, the second son of Mr. John Taylor, of Norwich, and great-grandson of Dr. John Taylor, of that city, was born in 1782. He was educated under the Rev. John Houghton, and early discovered a great fondness for the study of languages. On leaving school, he was apprenticed to Mr. Jonas Davis, printer, of Chancery Lane, to whose business he succeeded.

In 1817 he was unanimously elected one of the Common Council for the ward of Farringdon Without, which office he continued to hold for thirty-five years. In conjunction with Messrs. Wood, Waithman, and Favell, he soon distinguished himself as an enlightened and consistent friend of civil and religious liberty, advocating Parliamentary Reform, the repeal of the Corporation and Test Acts, Catholic Emancipation, and the abolition of every restriction on liberty of conscience and the right of private judgment.

As a member of the Corporation he took an active part in the establishment of the City of London School and the formation of the Corporation Library. He was one of the Committee intrusted with the rebuilding of the Royal Exchange and the restoration of Gresham College.

He joined with William Allen and other friends of edu-

cation in giving a cordial and active support to Joseph Lancaster, and he was one of the original subscribers to University College, of which his eldest brother, John, is still the Treasurer.

Mr. Taylor was a steady and consistent Nonconformist, descended from two of the illustrious band, who, in 1662, resigned their preferment in the Church for conscience sake: he adhered, from conviction, to those religious principles which have been hereditary in his family. His religious opinions were Unitarian.

His acquaintance with Sir Jas. Edw. Smith (in consequence of the friendship between the families at Norwich) began early in Mr. Taylor's life, and most of the works of the Linnean President issued from his press — the *English Botany*, the *Flora Græca*, and others. To this circumstance, probably, may be ascribed his fondness for the study of botany and natural history, as well as the appointment which he held in the Linnean Society.

In 1840 he edited a new edition of Warton's *History of English Poetry*, which he enriched with copious notes, containing many important additions and corrections. He had previously edited a new edition of Horne Tooke's *Diversions of Purley*.

For many years he was co-editor as well as printer of the *Philosophical Magazine*, a very useful publication, which would hardly have survived through so many changes of editorship, and so many commercial crises, if the printer had not been attached to the work by more than commercial ties.

He was early instructed in music, of which he was very fond, especially of the compositions of the old English masters. These he was accustomed to enjoy, and to join in singing at the Madrigal Society of the Purcell Club, having been for many years a member of both.

He died Dec. 1, 1858. For many years of his life he was a Fellow of our Society, and while his health lasted, a very frequent attendant. He was for some years the printer of our *Memoirs;* but his connexion with us neither began nor ended with business relations. His pleasant manners, his fund of information, and his readiness to be of use, made him an acquisition to every Society which he joined; and all felt that his removal made a void in their meetings. For years before his death the state of his health prevented his attending our meetings.

At the Royal Observatory of Greenwich the observations of all classes have been made with the same unremitting activity as in former years, and the reductions are made to keep pace with the observations with still greater punctuality than in former years.

The volume of Observations for 1857 has been for some time completely printed, and the publication of it may be daily ex-

pected. The printing of the volume for 1858 is proceeding rapidly.

The observations of γ *Draconis* with the reflex zenith tube are made without difficulty whenever the state of the sky permits the star to be visible.

The small planets lying between *Mars* and *Jupiter* are always scrupulously observed, though greater difficulty is experienced every year in identifying the whole of them, both from the want of correct ephemerides and from the exceeding faintness of some of those most recently discovered.

All the galvanic operations of the Observatory for the distribution of Greenwich time, for the drop of the balls in the Strand and at Deal, and for the regulation of the Post Office clocks in Lombard Street and at St. Martin's-le-Grand, are carried on with great regularity and with very few failures.

In the *Monthly Notice* for May last is an account of the operations performed at the Observatories of Greenwich and Edinburgh for determining their difference of longitude by means of galvanic signals. The operations were perfectly successful, as far as regards the passing of the current between the observatories; and a very good result would have been obtained, had not the weather at Greenwich been singularly bad throughout the week during which the experiments were made, so that stars could be observed on only one evening; on that evening the partial results were highly satisfactory, and the arrangements at both observatories were proved to be so complete as to leave nothing to be desired in the way of improvement.

The preparations for the mounting of the telescope of the great equatoreal were commenced at the beginning of the present year, and are proceeding rapidly. The polar axis has been framed and mounted with the hour-circle attached to it, and the mounting of the declination-circle is being proceeded with. There is reason to hope that this magnificent instrument will be completed and its telescope in use for astronomical purposes early in the approaching summer.

There is nothing new to report from the Radcliffe Observatory. The work has been carried on during the past year with its accustomed regularity. Since the last report, the 17th Volume of the *Radcliffe Observations* has been published; and the 18th volume is now printed, and will be published in the course of a few weeks.*

The Cambridge Observatory is diligently proceeding on its regular plan.

The planet *Leucothea,* which was looked for in vain in

* The Society will have learned with deep regret that, since our Annual Meeting, the distinguished Director of the Radcliffe Observatory has been carried off in the midst of his valuable labours. Mr. Johnson died suddenly on the evening of the 28th of February.—A. De M.

1856, was re-discovered by Mr. Breen on October 19 of last year, and was afterwards observed on four other days. Its extreme faintness prevented its being observed a greater number of times. Professor Challis is not aware of any observations of it at other observatories, excepting one made with the Cambridge equatoreal of the United States of America by Mr. Bond, to whom Mr. Breen's observations of October 19 and October 24 had been communicated.

The planet *Calypso*, the fifty-third of the group of minor planets, discovered on April 4 by Dr. Luther, at Bilk, was observed in consequence of a request from the discoverer that, as it is a very faint object, it should be followed with the Northumberland telescope. The Comet II. 1858, discovered on March 8 by Dr. Winnecke, assistant at the Observatory of Bonn, is found to be identical with Comet III. 1819, although it had not been seen till this year since the first discovery. Being engaged with other objects, Professor Challis did not attend to this comet till he received a request for observations of it with the large refractor from Professor Argelander, Director of the Observatory at Bonn, who considered it important, after the comet was found to be one of short period, to obtain observations extending over as long an interval as possible. Mr. Breen succeeded in observing it on the mornings of April 18 and 19, about a fortnight after the latest observations hitherto published. The comet could only be seen a very short time before dawn, when its altitude above the horizon was so small that, to obtain the above observations, it was necessary to cut off the tops of several trees in the south-eastern part of the observatory grounds.

The observations of planets, comets, and stars, were carried on to the end of the year on the same plan as in the previous part of the year (that stated at the top of p. 2 of the Report). Mr. Breen did not succeed in finding *Leucothea* at the opposition in November of last year, either because it was too faint, or because it escaped detection by being in the midst of a multitude of stars in the "milky way."

Donati's comet received particular attention, and drawings were made, and notes recorded, of its physical appearances.

A new determination of the effects of the forms of the transit-pivots made in the autumn of last year, taken in conjunction with those of preceding years, will enable Mr. Challis to reduce with greater exactness the transit observations taken in 1852 for obtaining the longitude of the observatory by galvanic signals, and to apply a small correction to the value of the longitude previously calculated.

Volume XIX. of the *Cambridge Observations* is in course of printing.

Mr. Breen resigned his situation at the observatory at the end of last year, after being assistant something more than twelve years. His place is not yet filled up, and the future arrangements respecting the assistants are in some uncertainty.

The most memorable fact relating to the prospects of this observatory, which occurred last year, was the donation by the representatives of the late Mr. Sheepshanks of 10,000*l.* to the University, for the promotion of astronomy. The University has accepted the donation, subject to the conditions that one-sixth part of the proceeds shall be applied to found an Astronomical Scholarship at Trinity College, open to competition by undergraduates of the other colleges; and the remaining proceeds shall be employed in promoting astronomical science in the University, and such other sciences as are usually pursued at an observatory. Among the purposes contemplated in the disposal of this fund are, the payment of assistants and computers at the observatory, and the purchase of astronomical instruments.

There is nothing of especial note to record connected with the Edinburgh Observatory. The determination of the longitude is now most satisfactory. The appointment of another assistant will enable the astronomer to keep the time-ball, which has now been used for some years, in a state of complete efficiency. On the subject of a second expedition to Teneriffe, Professor Smyth remarks:—

"Were foreign opinions needed to confirm those of the Board, most favourable testimony to the expedition of 1856 might be adduced in several languages; and the French *savans*, while hailing the Teneriffe experiment as quite a new era in the methods and proceedings of astronomers, and considering that they also should have a summer mountain observatory, yet with their characteristic courtesy, yield the *pas* to us as having established a scientific right to the Peak of Teneriffe, and content themselves with the Pic du Midi, though nearly 3000 feet lower, and not so favourably situated in latitude. If, then, after having found the experiment to be practicable and eminently successful as soon as tried in 1856, the moderate scheme proposed to the Board in 1852 had been then organised, we should have had in 1857 none to dispute our occupying the best astronomical observing station in this hemisphere, and many to applaud our doing so. But if there be much more delay, this unique opportunity for the Edinburgh Observatory taking a distinguished position amongst rival European institutions will inevitably pass away."

The Madras Observatory has been enriched during the past year by the addition of a new meridional circle resembling those at Greenwich and the Cape, but of a smaller size; being more nearly a copy of that erected by Mr. Carrington at Redhill, with a few slight improvements, the principal of which is a larger object-glass. This instrument reached India in March last, and is now in operation; and will probably be employed chiefly in observations of the planetoids (for which it is well adapted by its powers and construction as well as by geo-

graphical position), and in cataloguing small stars near the equator.

The Director, Captain Jacob, was again compelled by ill-health to leave his post in April last, and will most probably not return to it; his *locum-tenens* being Major Worster of the Madras Artillery. Captain Jacob brought home with him a selection of the most important of his observations during the last two years, the results of which are now in the course of publication in the Society's *Memoirs*.

In his annual report to the Mersey Docks and Harbour Board, Mr. Hartnup states that no material alteration has been made during the past year in the general routine duties of the Liverpool Observatory. The Greenwich Mean Time has been regularly communicated to the port by the dropping of the time-ball, and by the regulation of the electric clocks. The astronomical observations have been published as heretofore in the *Astronomische Nachrichten*, and in the proceedings of the Royal Astronomical Society. The observations taken with the self-registering anemometer and rain-guage have been tabulated for each hour of the day throughout the year. Diagrams of the strength and direction of the wind for each month in the year and for the six years preceding December 31, 1857, have been lithographed by order of the Dock Board. The pressure, temperature, and humidity of the atmosphere, have been regularly observed daily, and compared with similar observations taken during the preceding twelve years. The results thus obtained have been communicated to the Liverpool Medical Officer of Health. In addition to these ordinary duties of the observatory, Mr. Hartnup states in his report that they have, after some years' perseverance in explaining its advantages to mariners, succeeded in establishing a systematic method of testing chronometers, which is now so well appreciated that a business of considerable magnitude has sprung up in that department. The applications to have chronometers tested are gradually increasing, and it will be necessary very soon to have a new and much larger room built for the purpose of testing chronometers in. Mr. Hartnup estimates that there are on the average, in the port of Liverpool, upwards of one thousand chronometers belonging to ships lying in the docks, and he finds it a necessary precaution to test all chronometers when new, or when they have been cleaned or repaired; but he is of opinion that when these instruments are in good condition the less they are out of the hands of captains, or those who use them at sea the better, since it is by keeping a record of their performances at sea and on shore, in warm climates and in cold climates, that their peculiarities will be best made known to mariners who have to use their judgment as to the degree of confidence they are justified in placing in their instruments. He attributes the practice of sending chronometers on shore so

frequently to the difficulty of obtaining accurate time on board the ships lying in the Liverpool Docks; and he is supported in this opinion by the members of the Mercantile Marine Service Association, who have memorialized the Dock Board on the subject of additional time-balls. The desirableness of carrying telegraph wires along the whole line of Docks is now decided on; and it is proposed to connect the various turret-clocks on the dock-quays with the normal clock at the observatory, and to control their movements in the same way that the old turret-clock on the top of the Town Hall has been successfully controlled during the past two years. By this arrangement mariners will, by watching for the first blow of the hammer of either of these clocks, be able to ascertain correct Greenwich Mean Time at any hour of the day.

There has recently appeared in the *Monthly Notices* a letter from Mr. Maclear to the Astronomer Royal containing an account of the results of the Trigonometrical Survey in the Cape Colony. This communication, brief though it be, is eminently worthy of attention. The Cape Arc of the Meridian now extends from Cape Point in latitude 34° 21′ 6″·26 N. to latitude 29° 44′ 17″·66 N.; it has consequently an amplitude of 4° 36′ 48″·60. A comparison between the latitudes at the principal stations as determined by astronomical observation, and the corresponding latitudes calculated from Airy's elements of the earth's figure exhibits a satisfactory accordance. Only at one of the stations, Kamies Berg, does the outstanding difference appear to exceed the probable error of the observations. Mr. Maclear, however, remarks that the attraction of the immense Bushman Table Land, the mean elevation of which above the level of the sea is no less than 3000 feet, is capable of accounting for the deflection of the plumb-line indicated at this station. Captain Clarke has shown that by adopting this hypothesis, Mr. Maclear's results agree admirably with the elements of the earth's figure deduced in the recently published *Account of the Trigonometrical Survey of the British Isles.* The Society, we are assured, will cordially unite with the Council in applauding the ability and indefatigable energy which Mr. Maclear has exhibited in the execution of his arduous undertaking, and in offering him their congratulations on the satisfactory results at which he has arrived.

Mr. Lassell's telescope has been erected in all its ample proportions for about two months, and the great speculum has been in it for some six weeks; but an accident, in itself trifling, which occurred on attempting to turn the telescope about, made him think it prudent to make additions for greater strength and more perfect equilibrium.

With all his desire to keep down the massiveness of structure as much as is consistent with safety, he has got up to a weight of about a dozen tons; supported, if not precisely on three points,

yet on three surfaces respectively of very small area, on which moreover, smooth and steady—and as far as possible easy—motion must be obtained. He believes this is on the point of being done, and as the tangent-screws and apparatus for revolution in right ascension and polar declination are prepared and ready for attachment, as well as the finder, small speculum, and eye-tube, it cannot be long before he will be able to test the figure of the speculum by turning it on a star.

Mr. De La Rue during the past year has continued his experiments in celestial photography, and has made several improvements in the process; his observatory has been devoted chiefly to the delineation of our satellite, of which a great number of very perfect negatives have been obtained. Transparent positive copies on glass, 8 inches in diameter, have been presented by him to several observatories and astronomers; and he informs the Council that Mr. Fox Talbot has kindly proposed to apply his newly-invented art of heliographic engraving to the reproduction of one of the lunar photographs: should this be successful, it is hoped that the distribution of these beautiful objects will become more general. When two of the 8-inch photographs, presenting a sufficient difference in libration, are viewed by means of the reflecting stereoscope, the elevations and depressions of the lunar surface are made remarkably conspicuous, and an opportunity of studying the physical structure of our satellite is afforded which is likely to prove of value. The stereoscope adapted for the display of these photographs was exhibited at one of the meetings of the Society. Mr. De La Rue is at present engaged with experiments in photography with a 4-inch silvered glass reflector made by Dr. Steinheil, who has undertaken to make for him a 13-inch silvered glass speculum, with which it is probable that a considerable advance will be made in consequence of the greater amount of light reflected by silver in comparison with speculum metal, and the probability that the time of exposure of the collodion film will be considerably reduced. He informs the Council that he made one attempt to obtain a photograph of Donati's comet, but that he did not obtain any trace of an image in 60 seconds; this he thinks attributable to the low altitude of the comet at the hour he made the experiment, and not to want of requisite brightness of the comet itself. A severe domestic calamity prevented a repetition of the experiment under more favourable circumstances.

Although Mr. De La Rue was unsuccessful in producing an impression of the comet with his telescope of 10 feet focal length, Mr. Usherwood, an artist residing on Walton Common, succeeded in obtaining, in 7 seconds, a good negative with a portrait lens of short focus. The camera was stationary, hence the image is somewhat imperfect, nevertheless it bears enlargement of four times tolerably well. Mr. Usherwood's residence is situated about 700 feet above the sea-level, and it is possible that

his success is in some degree attributable to this circumstance, but is chiefly due to the large area of the portrait lens and the relative shortness of its focal distance. So far as the Council has been informed this is the only instance of a photograph of Donati's comet having been obtained.

The Photoheliograph erected in the dome of the Kew Observatory under the direction of Mr. De La Rue for the Royal Society, has been at work since the beginning of last March, and excellent photographic pictures of the solar spots and faculæ are obtained. Certain alterations have been made by Mr. Welsh, the Director of the Observatory, in order to regulate the term of exposure of the collodion plate to the sun's action; with these alterations the instrument gives very good results. The time of exposure necessary to produce a wet collodion picture even when the aperture is diminished to about 1 inch, and the image enlarged by the secondary lens to 4 inches in diameter, is only a very small fraction of a second. The apparatus for regulating the duration of light-action on the collodion plate consists in a sliding plate, having a slit which can be increased or diminished in width, and situated near to the collodion plate; this is moved by means of a spring rapidly across the interior of the telescope; and the time of exposure is governed partly by the regulation of the opening in the slit, and partly by accelerating or retarding the motion of the plate across in front of the sensitive plate. The work of the Kew photoheliograph has been of late interrupted by the illness of Mr. Welsh, but it is intended to appoint an additional assistant, whose duty it will be to take photographs of the sun each day that the weather permits.

At the suggestion of Mr. De La Rue, M. Otto Struve has proposed to the Academy of St. Petersburg to establish a photoheliograph in Russia, and the subject has received favourable consideration by that body. Thus it is very probable that Sir John Herschel's suggestion that the sun's spots should be daily recorded at several stations will soon be carried out.

Father Secchi continues to devote his refractor to photography, and has recently succeeded in obtaining a photograph of *Saturn*. The photographs of the moon produced by him have been distributed to several observatories.

Mr. Bond has communicated to the *Astronomische Nachrichten* a series of experiments on stellar photography, made under his direction by the photographers Messrs. Whipple and Black, at the Observatory of Harvard College, in 1857 and 1858. These experiments were made on the double-star *Mizar* and its companion, and on *α Lyræ*, with different apertures of the object-glass, from 1 inch up to the full aperture, 15 inches, and with different times of exposure. The object of these experiments was to ascertain the possibility of classifying stars according to a scale of photographic or chemical magnitudes

analogous to the common optical scale, but differing essentially in the fact of its being based upon actual measurements in the place of the somewhat uncertain estimates hitherto resorted to. Mr. Bond finds that a certain definite exposure depending on the brightness of the star is required before any trace of light-action can be detected on the collodion plate. At the expiration of that interval the photograph is suddenly developed by the clustering together of from ten to twenty molecules within an area of about 1 second in diameter. The number of molecules increases rapidly with the time of exposure, while the boundaries of the photograph extend on all sides. Mr. Bond remarks that the diffusion of light-action over considerable areas is obscure, and that if it were due to the dispersion caused by imperfection of the object-glass, it ought to be checked by reducing the aperture, which is not the case, he is inclined therefore to think that atmospheric disturbances may in part account for the phenomenon. Mr. Bond also finds that the images of stars increase by the addition of equal areas in equal times. Hence that, in comparing the photographic images of two stars, the time of exposure of each has to be taken into account. Mr. Bond has given several tables of comparison between the observed diameters of star-images and those computed according to formulæ he has proposed, which show a remarkable coincidence between the two values, proving the value of the photometric process.

From the date of our last Report till the middle of the month of July, Mr. Carrington was engaged, according to the plan there named, in the observation and reduction of the observed positions of the solar spots, which, from their increased number, and the circumstance of his being for the time without an assistant, was as much as he could attend to. Reductions had just been brought closely up, and the first arrangements considered for a thorough discussion of his accumulated records, when one of those events occurred, which must necessarily disarrange any man's plans, and Mr. Carrington found himself called upon, by the sudden death of his father, to take a leading part in a business of some magnitude, without so much as a day's warning beforehand of the change of occupation which was to come over him. He has not, however, entirely abandoned the astronomical subject he was pursuing, but has found time to deduce one or two conclusions of interest which have already appeared in our *Notices*, and is continuing his usual observations at the opportunities which remain to him, looking forward to a future date when leisure may be again at his command.

Mr. Carrington informs the Council that Mr. Marth, of Durham, though not provided with exactly the kind of instrument required, has at his request taken up the observation of the solar spots on the plan pursued by himself, and that Prof.

Secchi, of Rome, has also arranged for similar observations to be continued regularly, though on a different system.

The results which were laid before the Society in November indicate so clearly the necessity of continuing these or very similar observations for many years to come in unbroken succession, that the Council share with Mr. Carrington the anxiety he feels that the thread of labours which are opening out now with a bright prospect of success, may not be broken from want of co-operation. It would give them much pleasure to learn that one of the many observers in the United States had resolved to pursue this study with the continuity and assiduity which it requires; and if they may be permitted to name one above others, they would appeal to Dr. C. H. F. Peters, of Hamilton College, who has already, some years since, shown a personal interest in it, to come to the rescue.

Dr. Nichol, of Glasgow, continues his literary labours, and besides recording and fully discussing the meteorological indications of his station, has for some time past paid particular attention to certain physical features of the moon's surface. He promises the Society shortly an essay on the nature and chronological relations of the long streaks or rays which diverge from many centres, intersect one another, and are often dislocated in their course. Dr. Nichol explains, in a recent letter, that he has hitherto been unable to make much use of the meridian circle with which the Glasgow Observatory is furnished, on account of the optical inferiority of its object-glass. He has lately ordered a new one at his own expense from Mr. Cook, of York, with which he hopes to work with better results. He has also lately brought the whole condition of the Observatory under the notice of the Glasgow University Commissioners, praying for the appointment of a Board of Visitors, and for various ameliorations of its material condition.

At the beginning of this year Mr. R. Norman Pogson, whose name is well known to the astronomical world as discoverer of some small planets, and an observer of variable stars, took charge of Dr. Lee's Observatory at Hartwell. A course of observation has been arranged, and it may be confidently expected that the Society will hear of the results.

The year 1858, generally remarkable for the discovery of several comets, is memorable for the appearance of one of the finest and most interesting of those bodies which have been observed in the present century. Equally interesting to the professional astronomer and to the unlearned gazer in the heavens, it has been the object which has attracted to itself during the preceding autumn the undivided attention of the civilised world, and been the subject of intelligent study and speculation to the philosopher, and the reviver of astronomical tastes to the other classes of the community. It is a remarkable

feature of the present age that every phenomenon which is capable of adding to our knowledge of the facts or the principles of astronomical science is sure to be watched by a sufficient number of skilful observers to prevent the escape of any material circumstance or phase which might afterwards prove of theoretical importance, and to insure the complete discussion of all the physical facts that have been collected. And this is remarkably illustrated by the untiring zeal and industry, joined to the use of powerful instrumental means, and of consummate skill in the management of them, which have been brought into play in the case of the present comet. Not only has Donati, the fortunate discoverer of the comet at Florence, devoted himself unremittingly to the task of observing its positions and physical peculiarities,* but a friendly rivalry has been manifested at all the great European and American observatories to take every advantage of the time of its visibility. Parkhurst discovered it independently at Perth Amboy, New Jersey, United States, on the 29th of June, 1858; Chacornac at Paris has added to his well-established reputation by a most interesting series of physical observations made with singular care and perseverance (Le Verrier's *Bulletin* for Oct. 12); Pape at Altona has not only observed it with every care, but to him also are we indebted for a most elaborate memoir on the subject (*Astronomische Nachrichten*, Nos. 1172–4), in which he has applied Bessel's theory of opposite polarities to account for the oscillatory motion of the nucleus, and the formation of the tail, and has rigorously, and, as far as we can see, successfully, compared the theory with the observed phenomena, at the expense of a great amount of mathematical and computing labour. Professor Mädler of Dorpat (*Astronomische Nachrichten*, No. 1167) has made perhaps the best existing series of measures of the singular disks and aureoles round the nucleus which have been so conspicuous, and excited so much attention in the examination of the head of the comet; while Professor Heis of Münster devoted himself almost exclusively to the observation of the length and boundaries of the tail (*Astronomische Nachrichten*, No. 1169). Professor Secchi was unfortunately absent from Rome till the end of the month of October, but his absence was supplied so efficiently by his assistant, M. Rosa, and he took such good opportunities of seeing the comet himself, whenever a visit to any of the principal observatories that lay in his route permitted him, that he has been able to produce a very instructive and interesting memoir, entitled *Osservazioni della Cometa Donati fatti all' Osservatorio del Collegio Romano*, accompanied by several well-executed drawings of its various appearances. In England good observations have been made by the astronomers at Greenwich during the most interesting

* Donati's physical observations will be found in Le Verrier's *Meteorological Bulletin* for Oct. 25.

period of the visibility of the comet, both for fixing its positions by means of the altazimuth,* and for illustration of its physical peculiarities. The results of the observations are given in the November number of the *Monthly Notices* of this Society, and a series of well-executed chalk drawings was exhibited at the meeting of November 12, made by Messrs. Carpenter and Christy, gentlemen employed as computers at the Observatory.

As might be expected, Messrs. Dawes and Lassell have examined the comet with great attention, and the results of their labours have been given to the Society in two elaborate memoirs, their observations being illustrated by a series of careful drawings, which were exhibited at the meeting of January 14.

At Cambridge an excellent series of observations was made by Professor Challis and his assistant Mr. James Breen, of which the results relating to the physical appearances of the comet are given in the *Monthly Notice* for November 12, 1858. Many other detached physical observations will be found in the *Astronomische Nachrichten* and the *Monthly Notices*, of considerable value for corroboration of important facts which admit of any doubt, but the observations mentioned above are those which will be chiefly referred to by future inquirers into the origin of those grand and mysterious phenomena connected with the development and expansion of comets in the neighbourhood of their perihelia, and of which the ordinary theory of gravitation does not afford an adequate explanation.

As might be expected, the comet was observed most sedulously for the determination of its positions at most of the great observatories in Europe and America. The chief observations yet published are those which were made at the observatories of Dorpat, Florence, Geneva, Greenwich, Kremsmunster and Liverpool in Europe, and of Ann Arbor and Washington in the United States. (*Astronomische Nachrichten*, *Monthly Notices*, and *Gould's Journal.*) The results of the observations made at Cambridge (England) have not yet been made public. Several sets of elements and corresponding ephemerides have been computed by various astronomers, which must of course be considered only as approximative, and as forming the basis of an orbit to be determined by a careful combination and elaboration of all the observations as soon as they can be collected. At first it was thought that a parabolic orbit would satisfy the observations, but this was soon found not to be the case, and several sets of elliptic elements have been computed, differing, as might be supposed, very widely in the periodic time of revolution. The extreme periods of all the elements which we have yet seen are by Bond and Löwy, the former giving 12 years and 32 years in two distinct sets,

* For the reduction of these observations a tolerably accurate ephemeris was required, and this was supplied by the spontaneous zeal of Mr. Lynn, who willingly devoted his leisure to the labour of the requisite computations.

(Le Verrier's *Bulletin* for Sept. 19) and the latter giving 2495 years (*Astronomische Nachrichten*, No. 1164.) Other elements computed respectively by Bruhns (*Astronomische Nachrichten*, No. 1161), by Stampfer (No. 1163) and by Watson (*Gould's Journal*, No. 117), give for the period of revolution 2101, 2141, and 2415 years.

But, interesting as the comet is in its geometrical aspect as describing an orbit of this enormous length, whose proportions we have hope of ultimately determining with some degree of exactness, yet it is in its physical aspects that it offers at the present time most inducement for research and speculation; and a short history of the various phases which it exhibited from the time of its discovery till it was lost in the evening twilight at the latter end of October will be instructive and profitable. The three sets of physical observations which will best repay the labour of attentive study are; 1st, those which were made at the Observatory of the Collegio Romano, by M. Rosa, during the absence of Father Secchi, and which have been incorporated in the excellent memoir before cited: 2ndly, those made by the discoverer, Signor Donati, at Florence: and 3dly, those made by M. Chacornac at the Imperial Observatory of Paris. The memoir published by M. Pape in the *Astronomische Nachrichten*, Nos. 1172–74, in connexion with the observations made by himself and Professor Peters at Altona, and by Professor Mädler at Dorpat, is however by far the most complete and elaborate which has appeared, and must be read carefully by those who would seek to know how far Bessel's theory of solar polarity or repulsive force is borne out by the phenomena exhibited by the comet under discussion. To it we shall recur in the sequel; in the meanwhile we will give a brief sketch of the chief peculiarities exhibited by the comet.

Its discovery took place at Florence on June 2, when it presented the appearance of a faint nebulous patch of light without any remarkable condensation. As the comet's motion towards the sun was slow at that time, it was not till the beginning of September that any of the interesting appearances which drew to it such universal attention were exhibited. About this time it became visible to the naked eye, and a short tail was seen on the side opposite to the sun. The development was afterwards rapid. According to Professor Heis, on September 10, the tail was 3° in length, and on the 27th it had increased to 12°; on October 3 the length was 25°, and on the 6th it was 36°. A greater length is attributed by other observers, but the estimates of Professor Heis are worthy of great respect from the pains which he took to observe this element as his own especial province. At the time of the greatest development, or about October 5 and 6, the spectacle exhibited to the naked eye in the heavens was magnificent; and few persons who were fortunate enough to observe the transit of the comet over *Arcturus* will ever forget the impression made on

them by that sublime spectacle. The part of the comet which passed over the star was but a short distance from the head, and the motion was so rapid that the appulse of the star to the border of the train, the time when it arrived at the comparatively dark space in its axis, and the time of its coming out at the other side, could all be observed without any great tax on the patience of even an ordinary spectator. At this time the tail was sensibly curved, the convex side being uppermost, and in the direction of the motion. It was also well defined on this side, while on the other it was much more vague and indistinct. At one period, October 9, it shot forth a smaller tail, to a certain extent coincident with the larger one, but exhibiting little brushes projecting from the convex side of it. Altogether its appearance was like that of a large ostrich-feather when waved gently in the hand. But though the general spectacle as shown in the heavens to all who chose to gaze on it was so grand and beautiful, yet it is with the phenomena which took place in the head of the comet from the commencement of September to the end of October, as viewed through powerful telescopes, that the astronomer is chiefly concerned. These may be divided into three classes, namely, 1st, those that occurred during the month of September till the time of the perihelion passage on September 30; 2ndly, those that took place after this time near the time of nearest approach to the earth or on October 11; and, lastly, those that were observed at the time of the nearest approach to *Venus*, or about October 17. It may be mentioned in this place that the nearest approach to the earth was about equal to half the distance of the earth from the sun, and that the nearest approach to *Venus* was about one-ninth part of that distance. The appearances observed at Rome will be chiefly followed, as they agree well, on the whole, with those of Donati and Chacornac, and in a summary sketch of the leading features of the phenomena like the present, it is not worth while to record or even to notice the trifling discrepancies which occur between the observers, excepting to mention that they consist, first, in the micrometrical measures of the nucleus, and, secondly, in the large number of envelopes or *aureoles* which Chacornac saw (eight in all) successively issue in a spiral form from the nucleus, and ultimately and successively stream back on each side into the train, as other observers seem not to have recognised so large a number, and a little confusion may have existed in the enumeration of them.

On September 4, according to M. Rosa, the nucleus was bright and well-defined, and on September 11 the tail was about 4° 42′ long, and the nucleus was eccentrically situated within the envelope. On September 16 began those peculiar phenomena, which were watched with such anxiety and interest as long as the comet continued visible. On this day two diverging streams of light shot out from the nucleus, and after separating at the distance of about a diameter from it and pro-

ceeding for a short distance towards the head of the comet, they abruptly turned backwards and streamed into the tail. This is remarkable as being the first observed instance of that violent action by which the matter of the nucleus was constantly ejected from it while the comet was in the neighbourhood of the sun, and which, primarily by rapid expansion, and secondarily by some force apparently projecting it into the tail, formed the type of the various phenomena which were afterwards observed. The appearance of the two streams of light is represented by M. Rosa as similar in form to that presented by long hair when brushed upwards from the forehead, and then allowed to fall on each side of the head.

On the 22nd of September the "hair-parting" had given place to a fan-like bright sector, surrounded by a darkish arc, to which succeeded a brighter semi-circle of nebulous light; and on the 27th the same appearance continued, except that the fan was more spread out, and resembled in some degree the crescent form of *Venus*, with the nucleus projecting a little below the inner boundary, and with the line of cusps sensibly inclined to a perpendicular to the axis of the tail. On September 30, the fan still continued, its axis making with the axis of the tail an angle of 25°, and the black division of the latter being very dark near the nucleus. From this date, or almost immediately after the perihelion passage, was seen a totally distinct class of phenomena in the exhibition of the luminous envelopes which, either in a circular or parabolical form, surrounded the nucleus during the remaining time of visibility of the comet. On Sept. 30 three distinct envelopes were visible, the outer one being very diffused, the second better defined and brighter, and in appearance like the glory round the heads of saints; and the third (separated from the second by an interval less luminous) increasing in brightness towards the nucleus, with which it was at length almost confounded. In the direction of the tail a sector of about 90° was cut off from each of these envelopes, and this space beneath the nucleus was very dark. On October 4 similar appearances existed, except that the obscure arc had become a decided dark aperture and two little rays which were observed on October 2 had become curved. On October 8 great distortions were observed in the form of the outer envelope; and, as was generally observed under all the circumstances of this outstreaming of the matter of the nucleus, it was in that direction very ill-defined, and something very like the ragged ends of heavy rain clouds during a violent shower. On October 9 an additional fan or envelope was observed; and M. Rosa states that "the large one is now widened out at the sides, where the streamers are confounded with or run into the tail; the shadow of the nucleus is now also enlarged, and it seems as if the two streamers issuing into the tail were tending to surround the nucleus again so as to render the nebulosity round as at the beginning of the apparition of the comet." Similar appearances

were observed with some variations till October 15, when another set of phenomena were exhibited in the shape of "comma-like" curved appendages to the nucleus, as if the nucleus had thrown out from itself a large mass of brilliant or burning matter originally in a straight line, and this, by the action of some other force, were twisted violently round, and were ready to fall back again into it. These "commas," or pear-shaped appendages, continued with various modifications of size and form until October 22, when the extreme point of the virgula, or comma, had so far turned back again towards the nucleus as nearly to complete an elliptically-shaped body with its axis very much inclined.

The above are the principal phenomena which were observed by M. Rosa, and which form the chief materials of Father Secchi's memoir. They are better adapted than any others which we have yet seen, both by the continuity of the observations and the care which has been used in the descriptions and illustrative drawings, to convey an intelligible idea of the various and sudden changes of form which rendered the head of the comet so interesting an object of study. It is generally understood that both Professor Donati and M. Chacornac are preparing memoirs which shall embody the observations made by them much more completely than the remarks which have been published in Le Verrier's *Bulletins*, and till these have appeared it will be proper to defer any attempts to reconcile the observed phenomena with theory. In the meanwhile, however, speculation has not been idle, and if no successful attempt has been made to account for all the appearances, yet something has been done in the right direction by various astronomers, and especially by M. Pape of Altona, in addition to the hints thrown out by Father Secchi and M. Faye, which deserve notice.

Secchi attributes the observed phenomena, first, to the action of the sun both by gravity and heat, the heat, as the comet approached its perihelion distance, enormously dilating the gaseous mass of which it is apparently composed, and the unequal gravitation on the different parts of this immense mass producing enormous tides and disturbances. Observing also that some of the most interesting phenomena and the most rapid changes of form were shown, first, about the time when the comet was nearest to the earth, that is, near October 11, and, secondly, when the comet was nearest *Venus* (approaching within one-ninth part of the earth's mean distance from the sun) that is, near October 17, he attributes a direct disturbing influence to those two bodies tending to produce some of the observed irregularities and rapid changes of form. He also observes, as almost all other astronomers have done, from the fact of the light of the tail being polarised in a plane passing through its axis, that the light by which it is rendered visible is reflected from the sun.

In the *Revue Contemporaine* is an article by M. Faye, entitled *Idées Théoriques sur la Comète de Donati*, of which the Abbé Moigno has given an abstract in the Paris *Cosmos* for November 26, 1858. M. Faye proves that no mechanical action of the sun and of the mutually attracting particles of the cometary mass is sufficient to account for the observed phenomena; and he attributes them to some as yet unexplored action of the rays of the sun, which he presumes may be endowed with electro-magnetic as well as with calorific properties, and he refers finally to the theory before hinted at of Bessel who "attributes to the solar rays the property of producing polar forces or energetic attractions and repulsions in the cometary masses, but who has not been able to give a name to this property, although he has found it necessary to assign to the special action with which he endows the solar rays an intensity nearly the double of that of the attraction of the enormous mass which emits them."

The hypothesis of Bessel then, imperfect as it undoubtedly is, is the only one which offers anything like a solution of the difficult problem of reconciling with theory the observed phenomena exhibited by comets in their approach to the sun; and astronomers no doubt will make this the basis of their researches. It at least offers this advantage, that it can be submitted, under certain assumptions, to mathematical computation, and thus, even if it be not true, by reducing to some kind of law the observed phenomena, it may be conducive to the ultimate discovery of a true theory. One fact deserves to be stated distinctly before entering upon an explanation of the theory, namely, that the comparison of the appearances of Donati's comet with those of other large comets, especially those of the great comet of 1744, as described by Heinsius (*Acta Eruditorum* for 1745), and of Halley's comet at its apparition in 1682, (as delineated by Hevelius and reproduced by Admiral Smyth in his paper on Halley's comet in the ninth volume of the *Memoirs* of this Society) and also at its next apparition in 1835, proves that the phenomena are much less arbitrary than is generally supposed, and that they only differ as the individuals of a class differ from each other, and may be all combined in the attempt to develope any theory, due regard being had to the distances from the sun, the velocities, and other circumstances which may vary the phenomena.

Bessel, at the close of his memoir on the Comet of Halley, in No. 302 of the *Astronomische Nachrichten*, expounds his theory in these words:—"My exposition of the possibility of a connexion of all the phenomena observed in the comet is the following:—Every action of one body on another can be resolved into two parts; of which one is the same for all particles of the latter, and the other consists of the differences of the actions on the different particles. If the action at very great distances of the bodies from each other be very small, then it is

the former portion of it which, on the approach from these distances to smaller ones, first becomes sensible; the other may acquire a sensible magnitude afterwards. In the case of a comet, therefore, which at a very great distance is coming back to the sun, the first action which is shown is that which is common to all its particles; I assume that it consists in a volatisation of particles, which have opposite polarity to the sun (*welche der Sonne feindlich polarisirt werden*). The other part of the action, which is not sensible till later, may have, as a consequence, a polarization of the comet itself, and thus an especial outstreaming towards the sun. If observations really show these phenomena, as was the case in the Comet of 1744 and Halley's Comet, it cannot be denied that the outstreaming, since it issues from a part of the surface turned towards the sun, and therefore having a polarity of the same kind (*ihr freundlich polarisirten Theile*), possesses also that polarity which endeavours to bring the outstreaming particles nearer to the sun. That the outstreaming particles are, notwithstanding, driven back by the sun, as the observations show, may perhaps be explained by this consideration, that the outstreaming takes place into a space which is already filled with matter having opposite polarity and continues to be filled with it, whereby the opposite polarities balance each other, and the outstreaming particles lose the more of their original property and acquire the more of the antagonistic, the farther they recede from the nucleus of the comet."

This is Bessel's own exposition of his theory of opposite polarities, which depends upon several gratuitous assumptions, and which is therefore subject, *in limine*, to grave doubts — still some hypothesis of this nature is evidently required to explain the phenomena observed in so many comets, of particles streaming with great force from the nucleus towards the sun, and then turning back again away from the sun to form the tail. Bessel himself has applied the theory to the observed phenomena of Halley's Comet, and Pape has done the same for that of Donati, the work in each case involving a large amount of computation; and both astronomers are, on the whole, well satisfied with the resulting agreement between theory and observation, both with regard to the oscillatory motion of the outstreaming matter, and to the formation of the tail. But, whatever may be thought of the theory as capable of explaining *all* the phenomena, still it has great claims on the attention of astronomers as the only one which gives a tolerably satisfactory explanation of *any*, and that, by the simple assumption of certain forces brought into play under certain conditions, and without any *à priori* assumptions whatever as to the law or intensity of the forces, except the variation according to the inverse square of the distance. The intensity of the force, as deduced from the observations by Bessel in the case of Halley's Comet, is nearly double that of the gravitating

power of the sun, and in the contrary, that is, a repelling, direction, while Pape, in the case of Donati's Comet, finds different values for different periods before and after October 9, at which time a rather abrupt change of figure took place.

The Council have thought it worth while to enter thus minutely into the details of the observations and discussions respecting Donati's Comet with the idea of impressing upon astronomers their sense of the importance of its appearance as tending to throw light upon some of the physical peculiarities of these mysterious bodies, and also of saving trouble to zealous inquirers by giving information with respect to the works wherein the chief materials at present exist for obtaining the data of future research, and of pointing out the state of the problem as it has been left by Bessel and other great astronomers. The apparition of so interesting an object as Donati's Comet has a wonderful influence in awakening an interest in astronomical science generally; but especially is it important in quickening the zeal of those who are capable, by their mathematical attainments, of taking part in the solution of the abstruse problems connected with any physical theory which may explain the phenomena of cometary bodies, and of deducing from the observations all the information which they are capable of conveying.

Since the preceding account was written, an excellent account of the observations made at the Observatory of Harvard College, Cambridge, U.S., has been published by Mr. G. P. Bond. The account is extracted from the *Mathematical Monthly Magazine* for November and December 1858, and is accompanied by two fine steel engravings and twenty-one woodcuts. Since it can be purchased at a low price, and will probably be in the hands of most English astronomers, the reference here given will be sufficient.

During the past year a volume has been published by Col. James, Superintendent of the Ordnance Survey, containing an account of the operations for determining the principal Triangles of the Survey, and the investigation of the figure, dimensions, and mean density of the earth, hence deducible. The researches recorded in this immense volume (extending to nearly 800 quarto pages) are executed in the most complete and masterly manner, and reflect high credit on the mathematical talents of Captain Clarke, to whom the more important portion of the volume is attributed. Some of the principal results have been already brought before the notice of the Society, both in the Annual Report of last year and in a subsequent number of the *Monthly Notices;* but the Council could not omit this occasion of expressing their unreserved appreciation of a work which is destined in future ages to occupy an important place in the history of geodesical science.

In the *Berlin Jahrbuch* for 1861 there appears a remarkable paper by Professor Encke, in which the author has collected together the results of his various researches on the existence of a resisting medium, extending over a period of nearly thirty years. As an abstract of this paper has already appeared in the *Monthly Notices*, it will not be necessary, on this occasion, to enter into any details with respect to its contents; but the Council cannot omit to express the high opinion which they entertain of its value as a contribution to physical astronomy. It may be stated that the researches of Professor Encke are founded exclusively on the observations of the comet which bears his name. Soon after his discovery of the periodicity of the comet in 1819, he was led to remark that the time of revolution, as determined by a comparison of the apparition of that year with the previous apparitions in 1805, 1795, and 1786, was gradually diminishing; and it occurred to his mind, at this early period of his labours, that the effect might be due to the influence of a resisting medium. On every subsequent occasion of the comet's passage of the perihelion he has calculated beforehand an ephemeris of its apparent place, extending over a sufficient interval of time, taking into account the effects of planetary perturbation, and introducing the hypothesis of a resisting medium; and the results thus obtained have been found, in general, to represent the actual positions of the comet within the limits of the probable errors of observation. The quantity by which each successive revolution of the comet has been found to diminish amounts to $\frac{11}{100}$ths of a day, or rather more than two hours and a half. While the existence of a gradual diminution of the time of revolution of the comet must now be universally admitted as a rigorously demonstrable truth, it must be borne in mind that the establishment of this important fact is wholly due to the able and persevering exertions of Professor Encke. The annals of astronomy contain few more brilliant examples of successful achievement, whether viewed in regard to the pertinacity with which the researches were pursued, the confidence by which the inquirer was invariably sustained throughout his arduous labours, or the importance of the final result. With respect to the physical cause of the fact discovered by Professor Encke, differences of opinion may be entertained in the present state of the question; but it may be reasonably expected that a result of such importance will in due time lead to conclusions of high interest in astronomical physics.

The Council would direct the special attention of the Fellows of the Society to the New Solar Tables by M. Le Verrier, recently published in the fourth volume of the *Annales de l'Observatoire.* This volume contains not merely the tables, but the whole materials of their construction, treated in the most masterly manner. First, the author gives the general

theory of the earth's movement, and rigorously calculates the effects of planetary perturbation. He then proceeds to a discussion of the observations, by means of which the elements of the terrestrial orbit are corrected. These consist of nearly nine thousand right ascensions of the sun, as determined at the Observatories of Greenwich, Paris, and Königsberg, between the years 1750 and 1850. Besides general tables, in which the values of the various inequalities are distinctly computed for successive values of the arguments, there are special tables for the computation of ephemerides, founded upon the results contained in the general tables. In the latter instance the sun's longitude and radius vector are computed with great ease by a process of admirable simplicity. It is worthy of remark, also, that the right ascensions may be found with the same facility, independently of the longitudes. Tables distinguished by practical advantages of such undisputed value cannot fail to recommend themselves to the astronomical computer.

The year 1858 saw the conclusion of the series of star-charts published by the Academy of Berlin. Distinguished as are the names of the contributors to this celebrated work, the retrospect of the undertaking can hardly be regarded as encouraging to those who look to great results from voluntary co-operation. Thirty years have elapsed since their commencement, and many a chart has had to be transferred to other hands than those which were pledged to its performance. A fair estimate of the time necessary for work thus apportioned would be three years for the observation, and five for the observation and publication; yet thirty have really been required. The result is, that though the series has at last been concluded, and the latter sheets prepared consistently with the original plan, other charts have long since been set on foot, of larger scale and greater detail, and the later members of the family have been much depreciated in value by the progress of discovery in the department for which they were specially designed. Nevertheless, the formation of these charts gained for Berlin the honour of the first recognition of the planet *Neptune*, and greatly promoted the search for minor planets in their earlier days. The execution of the engravings has been uniformly good throughout, and the muster-roll of names which appear upon them will ever have historical interest.

Dr. Argelander's survey of the northern heavens is steadily progressing at Bonn, and the third series of his lithographed charts has appeared. He has for some time expressed the wish that some countryman of ours, with "*Englische Geld und Englische Kraft*," will undertake a similar survey of the southern hemisphere from some station such as the Cape of Good Hope.

The sun was twice totally eclipsed during the year,—in the months of March and September. The augmented diame-

ters of the sun and moon were, on the first occasion, so nearly equal, that while the eclipse was complete in the neighbourhood of the Canary Isles, it was just annular in the part of its track which crossed England. Considerable preparations had been made for its due observation over a large tract of country; and, in curious contrast to the terror of bygone times, were to be seen on most of our railways bills announcing that excursion trains would convey amateur astronomers—schools at reduced charges—to the spot on their different lines previously indicated by the computers. Numbers availed themselves of the opportunity; but our cloudy spring climate doomed the greater part to disappointment, a broken pack of light clouds coming over the scene from the north-west, and, with a few exceptions, obscuring the view of successive groups of gazers shortly before the greatest phase. The physical appearances attending the rupture of a thin strip of sunlight were best seen at Cambridge by Mr. Breen, who, having the use of an instrument of great power, was able to add something to the particulars of former descriptions. The central line was found to deviate sensibly from its position computed from the tables of Hansen, but the deviation was subsequently shown by Mr. Farley to be accountable for by very minute errors of geocentric place. The *Monthly Notices* contain the chief accounts of observers on this occasion.

For the September eclipse further preparations were made, and a pamphlet was written by Mr. Carrington, containing some necessary information and suggestions. Whether from the partial failure in March, or from other discouragements presented by the climate, the distance, and the unavoidable expense, no observer in this country could be induced to volunteer for a voyage to the Brazils; and though some efforts were made to organise an expedition, and Mr. Robert Stephenson again offered his yacht Titania for the voyage to a well-known member of our Council, the opportunity was neglected as far as this country was concerned, and the French Government sent out the only European observer who, in the end, contributed to our knowledge on the occasion. M. Liais, the astronomer alluded to, connected himself with an expedition to Paranagua organised by the Brazilian Government; and the joint report produced by the Commission shows that their well-directed efforts were not baffled by climatic obstructions, though they ran more risk from this evil chance than had been anticipated. The report referred to will be found published *in extenso* in Nos. 1170, 1171 of the *Ast. Nachrichten*, and its main features in a condensed form in the *Monthly Notice* for November last. The sketch of the appearances seen during the total obscuration of the sun, which accompanied the Report, has been framed, and now hangs in our meeting-room. The corona visible during the interval of total obscuration, appears from the various accounts to have

exhibited an unusually complicated structure on this occasion. Several conical brushes of light, with convex sides, were seen around the moon's limb extending to an average distance of 13′, besides two radial emanations of greater length, darting out from beneath the opposite extremities of the moon's horizontal diameter. From an observation made by M. Liais, it would appear that the conical brushes of light were in reality appendages of the sun, and not of the moon. Several protuberances were remarked around the moon's limb during the totality of the eclipse. In some instances they exhibited the usual rose-colour, but in general they had a white aspect. The sun's disk had been carefully scanned a few days beforehand by various observers, with the view of being enabled subsequently to ascertain whether any of the spots or faculæ would correspond in position to the protuberances which might be seen during the eclipse, but no such relationship between the two classes of phenomena was discoverable.

Since the last Anniversary of the Society four new members of the group of minor planets have been added to the solar system. The first, *Calypso*, was discovered on the 4th of April, at Paris, by M. Goldschmidt; the second, *Alexandra*, was discovered by the same indefatigable observer on the 10th of September; the third was discovered also on the same evening by Mr. Searle, at the Observatory of Albany, U.S. The circumstances connected with the discovery of the fourth planet are of an unusually interesting character. It will be in the recollection of the Fellows of the Society that the planet *Daphne* was discovered by M. Goldschmidt on the 22d of May, 1856. At the time of its discovery the planet had considerably passed opposition, so that only four observations of it could be obtained before it ceased to be visible. An orbit was calculated from these observations by M. Pape, but it was justly feared that in consequence of the small extent of the arc of observation, considerable difficulty would be experienced in the rediscovery of the planet upon its coming to opposition in the following year. However, on the 9th of September, 1857, M. Goldschmidt, aided by an ephemeris founded on M. Pape's orbit, discovered a planet which was supposed to be *Daphne*, and a considerable number of positions of it were obtained at various observatories during the period of its visibility. It has already been mentioned in the *Monthly Notices*, that the object discovered by M. Goldschmidt on the 9th of September, 1857, was in reality not *Daphne*, but a new planet, and that the detection of this curious fact is due to M. Ernest Schubert. The aggregate number of small bodies constituting the group of minor planets now amounts to fifty-six.

There a practical consideration which the continued ad-

dition of planetoids to the known system brings each year more into view, which it may be worth while to repeat on this occasion with further distinctness. It is the constant and pretty regular decrease of brightness, or so-called magnitudes, of the successive additions. For instance, we find a mean-opposition-magnitude of 8·6 for the average of the first ten, of 9·6 for the second ten, of 10·4 for the third ten, of 10·9 for the fourth ten, and about 11·4 for the fifth ten; numbers which indicate pretty plainly what the optical requirements of the successful observer will be in the immediate future, if the course of discovery is to continue as of late. These numbers also indicate that a great eventual saving of labour may be made by *at once* carrying the mapping of stars in the regions of search to a degree of minuteness, many degrees of magnitude beyond that of any existing charts, and by furnishing observers engaged in the work of search with instruments of corresponding power. At present the sieve is too coarse.

These remarks will sufficiently show that the Council are not of those who think that the progress of discovery in this department is or may be too rapid; on the contrary, while the direct stimulant of personal reward seems scarcely needed by the untiring zeal of competing astronomers, they continue to point with increasing satisfaction to their labours as one of the most remarkable instances of continued progress in the history of astronomy, and to a dense body of atoms of fact which have changed the face of the solar system, and are essential as features in any great speculation as to its past history and formation.

The twelve months which have elapsed since our last Anniversary have been distinguished by the discovery of four new comets and the rediscovery of two periodic comets.

The first comet was discovered on the 8th of March at Bonn by Dr. Winnecke. A comparison of its parabolic elements with those of a comet observed in 1819, seemed to indicate that both bodies were identical, and, in fact, it was found by the discoverer that the observations would be best satisfied by an elliptic orbit with a period of 5·549 years. Supposing the comet to have made seven revolutions since its apparition in 1819, the time of revolution would be 5·541 years, a result agreeing very closely with that derived from theory. It can hardly be doubted, therefore, that both apparitions refer to the same object, and that the time of revolution has been determined with considerable precision.

The second comet was discovered on the 2d of May at the Observatory of Cambridge, U.S., by Mr. Tuttle. A parabolic orbit has been found to satisfy the observations.

The third comet was discovered on the 21st of May at the Berlin Observatory by Dr. Bruhns. In this case, also, the elements have been found to be sensibly parabolic.