whom all the specimens were submitted for scrutiny, would be able to construct a lens of sufficient size to be fairly tried, and thus crown the long-continued labour with a permanent benefit to science.

It was hoped that a full account of these experiments might have been prepared by the author of them, for his strong mind felt little of the weight of eighty years and overruled the bodily infirmities of age. But it was a character of the man never to cease experimental or literary research till he was satisfied; resolute to contend with difficulties till all were overcome, and too truly a lover of knowledge, with faith in its progress, to be hasty in publishing views on account of their novelty, which might be made valuable by proofs of their truth. Prof. Stokes has already presented to the British Association a notice* of these researches, and to him we must now look for further records of a work to which he has cheerfully contributed a large amount of valuable aid.

The scientific pursuits of Mr. Harcourt were followed in the midst of great occupation as a clergyman, not only in charge of his parish, but open to perpetual demands for help in public institutions of an educational and charitable character. The York School for the Blind, founded in honour of Wilberforce, the Yorkshire Hospital, the Castle Howard Reformatory, experienced the benefit of his guidance; indeed hardly any great movement in Yorkshire in favour of useful learning and comprehensive Christianity was carried on without his help, often given when his own health required cessation from labour. At many public meetings for these objects his place was to preside—a duty for which his thoughtful words and dignified presence, and a certain natural union of gentleness and firmness, admirably qualified him.

Though never a person of robust health, Mr. Harcourt was not much troubled by positive illness till towards the close of his life, when he became confined to a home rich in books and monuments of art, surrounded by a cheerful family, to which the graceful hospitality which had become a habit of his life brought many additions from the large range of his personal friendships and the more limited circle of men devoted to literature and science resident in his own neighbouring University. He had been elected a Fellow of the Royal Society in 1824. His death occurred at Nuneham in April 1871.—J. P.

In John Frederick William Herschel British science has sustained a loss greater than any which it has suffered since the death of Newton, and one not likely to be soon replaced. Though none of his discoveries were as brilliant as Davy's decomposition of the alkalies, or Faraday's magneto-electric induction, yet they ranged over a wider field than either of these philosophers could explore, and many of them are of first-rate importance. And of even higher value was the influence of his teach-

* Read to the British Association Meeting in Edinburgh, August 1871.

ing and example in wakening the public to a perception of the power and beauty of science, and stimulating and guiding its pursuit.

He was born March 7, 1792, at Slough, a spot consecrated by the work of his illustrous father; an only child, he grew up with nothing to weaken the effect of the glorious pursuits and magnificent objects with which he was familiar. He was educated at home, but most successfully. He was a good classical scholar, a poet, an accomplished draughtsman, an excellent musician; he spoke fluently several foreign languages, and was well versed in their literature. In 1809 he entered St. John's College, Cambridge, through which he passed with the highest honours, graduating as Senior Wrangler above Peacock. In conjunction with Peacock and another distinguished man of the following year, Babbage, he took an active part in a controversy then raging at Cambridge. From reverence to the memory of Newton, from limited intercourse with the continent, and perhaps from national prejudice, British mathematicians had advanced scarcely a step beyond their great master; and it was scarcely possible for them to do so while they retained the Fluxional notation.

If we compare the treatises of Fluxions which at the time in question were current in the University with the French or German text-books on the same branch of analysis, we must be thoroughly ashamed, and almost disposed to admit the contemptuous statement of an Edinburgh reviewer, that there were in Great Britain only four men who could read the 'Mecanique Céleste,' and that three of them were Scotchmen*. In all such transitions, besides the effect of habit, the adherents of an old theory are often bound to it by personal feelings, as if the giving up their former convictions implied some intellectual inferiority; and it may happen that the champions of the new one do not bear their triumph meekly. At Cambridge, however, the struggle was not long; for Woodhouse, the originator of the movement, was powerfully seconded by Herschel and his friends even while undergraduates. From them came the memoirs of the Analytical Society, the translation of Lacroix's 'Differential and Integral Calculus,' and the examples of the same calculus, which virtually decided the question. The treatise on the calculus of finite differences which this last volume contains, and which was the work of Herschel exclusively, is specially valuable. Henceforward he entered on a wider field of labour, where the limits of this notice do not permit us to follow him; for of him it may be said, as in Goldsmith's epitaph, "Scientiæ nullum non genus tetigit, nullum quod tetigit non ornavit." For sixty years he enriched the Royal and other Societies with memoirs, precious not merely for the truths which they reveal, but for their suggestive character and their lucid developments. Their number and quality might seem great enough to overtask the energy of most men, yet they were supplemented by several sepa-

* Probably he meant by the three, himself, Brougham, and Ivory; of Ivory this was true, but the competence of the other two for such a feat is very questionable.

rate treatises of great importance*, and by a profusion of lectures, reviews, and other contributions to periodical literature†. Out of this wonderful collection a few specimens may be selected.

Of all his writings, that which has been most universally admired and whose influence has been most widely felt is the "Discourse on the Study of Natural Philosophy," which in 1830 appeared in 'Lardner's Cabinet Cyclopædia.' For power and elegance of language, for clearness of illustration, for sound and far-sighted judgment, this little book cannot be surpassed. Of course the progress of research enables us now to see further in some directions than he could then anticipate, and the principles enunciated in the first chapter have roused the ire of some of the philosophists of the day. They, however, are proof against the cavils of such rash speculators, for they are in perfect unison with the noblest aspirations and highest intuitions of human nature. Of his purely physical works the astronomical portion must hold the first place as a stupendous monument of unwearied labour, guided and enlightened by high theoretic anticipations and consummate skill.

As his father's greatest triumphs were achieved in the regions of double stars and nebulæ, it was natural that his thoughts should be turned in the same direction, and that he should be impelled to complete as far as possible what Sir William had left imperfect. As early as 1821 he is found associated with Sir James South in forming a Catalogue of Double Stars, which appeared in our 'Transactions' for 1824, and was honoured with our medal. This union of labour was soon interrupted. South moved his observatory to Passy in quest of a clearer atmosphere than that of Blackman Street. Herschel also went to the continent. His friend Babbage had been overwhelmed by a domestic calamity, and Herschel abandoned his own pursuits to aid time and change of scene in alleviating the affliction of his companion‡.

On his return to Slough he resumed the double stars, and by 1832 he had observed 5075 of these objects, a large portion of which were new to astronomers. Most of these were observed with the 20-feet Herschelian reflector; and only they who have experienced the difficulty of obtaining good measures of a double star even with a steady equatorial can rightly appreciate the merit of such work performed with an instrument mounted as this was (see the drawing of it in the frontispiece of the 'Cape Observations'). The results were published in six memoirs, the last of which

* Two of these are of great value,—that on sound in the 'Encyclopædia Metropolitana,' and that on telescopes in the 'Encyclopædia Britannica' (this contains a description of the polishing-apparatus of his father).

† He was often requested by the Council of the Royal Society to report on papers submitted to it for publication. Some of these Reports which the writer has seen are so full of valuable matter as to make him regret that the rules of the Society do not permit their publication.

‡ In their tour they were received with great kindness by Laplace, who was fully cognizant of what they had done at Cambridge, and referred to it with much pleasure.

did not appear till 1836, for the necessary reductions (in which he had no assistance except from his aunt, the celebrated Caroline Herschel) required much time and labour.

His catalogues differ from those of his father in one important particular: they give the place of an object by its right ascension and polar distance for 1830, so that it can be easily found by a graduated instrument; whilst Sir William gave only its distance and angle of position with respect to the nearest of Flamsteed's stars, both of them mere estimates—a plan which, besides its uncertainty, was necessarily tedious.

But along with this great work he was engaged with the revision of his father's catalague of nebulæ and the discovery of new ones; and here the boon which he conferred on astronomy was still greater, such, indeed, as none but himself could have bestowed, for his telescope far exceeded any then existing in illuminating power. His earliest publication on this subject was the fine monograph and drawing of the nebulæ in Orion, dating from 1824; but this was nobly followed out by his great Catalogue of Nebulæ, which appeared in our Transactions for 1833. It contains 2307 nebulæ and clusters, of which more than 500 were discovered by himself. In this also the right ascension and polar distance of each object are given for 1830, and it is enriched with many admirable drawings of such as offer some striking peculiarity. As might be expected, some of these have been found to omit details which are shown by the instruments of greater power which have been since constructed; but their general accuracy is acknowledged by all conversant in this kind of observation; and their value is shown in more than one instance by enabling subsequent observers to detect changes in the nebulæ *.

The memoir which accompanies this catalogue is of high interest, full of vivid description, of far-reaching views, and enlightened speculation. Having so thoroughly explored the northern sky, he might have rested well satisfied with his work; but he felt the importance of extending it to the southern hemisphere, and of leaving to posterity a complete survey of the heavens, which, as made by the same observer and with the same powerful telescope, would be a record to which future observers might refer with confidence. With this view, and by his unaided resources, he removed, in the beginning of 1834, his family and instruments to the Cape of Good Hope, where he remained for four years, observing with intense activity, and exerting on the leading spirits of that colony an enlightening influence, the effects of which are still felt there. The results which he obtained were given to the world, not in separate memoirs, but in one volume, published in 1847 by the munificent aid of the then Duke of Northumberland. It contains catalogues of 2102 double stars and 1707 nebulæ, with elaborate drawings of many of the latter and minute surveys of the stars

* In comparing these drawings with the present appearance of the nebulæ, the telescope used should be made equiluminous with the 20-feet; for this purpose in a Newtonian the aperture should =23·14, in an achromatic =16·86.

adjacent to them. Some idea of the labour thus expended may be gained by the fact that for the two "Magellanic Clouds" 1143 stars, nebulæ, and clusters were carefully measured, and 1203 stars for the great nebula in Argo. Of the splendid monograph of this wonderful object which he has given it is impossible to speak too highly, especially as, notwithstanding some conflicting testimony, the comparison of it with recent observations gives reason to believe that this nebula has undergone surprising changes in the last thirty years. Independent of these precious catalogues the volume is like a perfect gem; besides the charm of its style, it is a rich treasury of varied knowledge. As an example may be named the section on the causes which injure the action of reflecting telescopes, the chapters on astrometry, on Halley's comet, and on the solar spots; they all bear the stamp of a Master's hand, and contain suggestions all striking, and of which some have since been applied with the best results to practice. His labours on nebulæ were completed much later in life by a general catalogue of them containing 5079, which appeared in our 'Transactions' for 1864. This includes all contained in his former catalogues and all discovered by others up to that time. It contains the places for 1860, and their precessions for 1880; so that it will be easily available for observers to the end of the century, and will long be their Manual of Nebulæ.

His contributions to optics rank next to his astronomical in importance and number; but we shall only mention two, which gave a great impulse to the progress among us of this branch of physics. The first is a remarkable memoir on the aberrations of compound lenses and object-glasses, which appeared in our 'Transactions' for 1821. Before it opticians (at least in this country) corrected the spherical aberration of their object-glasses by empirical rules, and its theory was given in rude and unsymmetrical forms. By a happy choice of symbols and an elegant analysis he presents the theory of aberration in all its generality, and in as simple a manner as the nature of the question admits. He gives examples of the application of his theory to the construction of aplanatic doublets, and then to that of object-glasses. In discussing this he considers the dispersive power as composed of several terms, of which the first only is taken into account by opticians, and the rest constitute the irrationality of the spectra. This defect cannot be removed in a double object-glass unless the dispersive powers of higher orders are proportional to the first; and he recommends that the attention of future inquirers should be directed to the discovery of such a medium (a result which there is reason to believe has at last been obtained by the combined investigation of the late W. Vernon Harcourt and Professor Stokes).

The condition which he assumes for correcting the spherical aberration is, that the compound shall be aplanatic for near as well as remote objects. He tabulates the results for the various crown and flint glasses then used in England with a completeness which leaves nothing to be desired. It may be feared, however (notwithstanding the popular explanation of his method

which he afterwards published in the sixth volume of the 'Edinburgh Philosophical Journal'), that this paper has had little influence on the practice of British workmen, who then and now are far behind the requirements of the age in the knowledge of geometry.

It is evident that when he wrote this memoir Herschel did not accept the wave-theory; but in 1830 appeared in the 'Encyclopædia Metropolitana' his Treatise on Light, where it is brilliantly developed. In this work, which is still read with admiration and profit, the first part is an excellent system of ordinary optics, in which is included the substance of the previous memoir: then he states the emission and wave-theories of Light, applies each of them to explain the laws of reflection and refraction and the phenomena of Newton's rings and diffraction fringes, states the objections to each, and shows the superiority of the latter as irresistible. He next describes with singular clearness the phenomena of Polarized Light (not a few of which were discovered by himself), and gives their theory; and completes the work with the absorption of light and the effect of mechanical force on the optical properties of transparent media.

In other departments of science it must suffice to notice his investigations of the hyposulphites, to which photography is so deeply indebted; his researches on photography, including some curious and beautiful processes, and of which it may be remarked that he very nearly anticipated Mr. Fox Talbot in the discovery of the paper process; and his invention of the Actinometer. Nor is to be forgotten that on several occasions he gave powerful aid to the establishment of those simultaneous magnetic surveys which, under the auspices of Sir Edward Sabine, have thrown such light on the study of terrestrial magnetism.

It remains to say a few words as to his personal character; for a man, however high and varied his knowledge of physics or geometry, is a very imperfect specimen of his race if he be deficient in those higher qualities which should regulate morals and the duties of life. Herschel could abide this test. He was deeply and unostentatiously religious; exemplary in all the social relations. If his devotion to his father might seem excessive, it should be remembered what a man that father was. Far above the petty jealousies which haunt meaner minds, he was always ready to do the fullest justice to the labours of others, regarding them as fellow-labourers in a great work, not as rivals; and when it was his lot to be engaged in controversy, which he avoided as much as possible, he never allowed it to hurry him into any thing unworthy of a Christian gentleman. A beautiful trait in his character was the interest he took in those who, as yet unknown, were beginning to climb the ascents of science, and the encouragement he was always ready to afford them. One instance of this which it was the writer's lot to witness struck him so much that he ventures to mention it here. At an early meeting of the British Association a rough-looking man brought forward a paper on the strength of iron; unaccustomed to such an audience, his presence of mind failed, and he sat down muttering

"I can't go on." He sat down next to Herschel, and another paper was proceeded with; but Herschel after a little began to whisper to him: at first, in his agony of confusion, he seemed not to hear; but Herschel persevered, asked what his views were, spoke well of them, and, as his countenance brightened, asked leave to look over his paper, and having done so, encouraged him to bring it forward next day. But for this wise kindness that man might have relapsed into obscurity; but, as it was, he became ultimately a Fellow of our Society, and one of the highest authorities in a very important branch of mechanical engineering.

Herschel married Miss Stewart in 1829, and had a large family, of whom two sons are well known to us—Professor Alexander by his study of Meteorites, and Captain John, attached to the Indian Survey, distinguished by spectroscopic observations of the sun and other heavenly bodies.

He was created a Baronet in 1838. In 1850 he, as Newton before him, was appointed Master of the Mint. That establishment was undergoing an important change, its emancipation from the old Corporation of Moneyers; and the whole of its reorganization devolved on him. He also introduced an important check, which, however, has been discontinued since his successor's death. The official assays were controlled by others, made by two unofficial chemists, those whom he employed being Graham and Allen Miller. This office his failing health obliged him to resign after five years.

He was a President of the British Association and of the Astronomical Society. In 1855 he was nominated one of the eight Foreign Associates of the French Academy of Sciences, and was a member of almost every Philosophical or Literary Society of Europe.

His mind continued as clear and active as ever to the very last. He died on the 11th of May, 1871, and he was buried in Westminster Abbey by the side of Newton.—T. R. R.

William Baird, M.D., F.R.S., F.L.S., &c., was the youngest son of the Rev. James Baird, and was born at the Manse of Eccles, in Berwickshire, in 1803. He was educated at the High School of Edinburgh, and afterwards studied medicine and surgery in the University of that city, and in Dublin and Paris.

In the year 1823, Dr. Baird, having previously made a voyage to the West Indies and South America, entered the maritime service of the East-India Company as surgeon, and remained in that service until 1833. During this period he visited India and China five times, also other countries; and in all his voyages availed himself zealously of the opportunities for studying his favourite science of Natural History which his position presented to him. In 1829 Dr. Baird assisted in the foundation of the well-known Berwickshire Naturalists' Club (to the publications of which he was afterwards a frequent contributor). The admirable example afforded by that institution has led to the formation of similar Associations