for their hospitality in granting the use of the Hall, and Dr. Butler replied on behalf of the College.

In addition to the guests who were more directly associated with the celebration of the jubilee, the following were present at the banquet:—Mr. Justice Mathew, the High Sheriff of Cambridgeshire, the Lord Lieutenant of Cambridgeshire, the Bishop of Ely, the Right Hon. A. J. Balfour, and many other distinguished guests.

This dinner brought the official proceedings to an end, but on Monday a meeting of the Philosophical Society was held for the presentation of papers to be published in a special volume of the Society's *Transactions* commemorative of the long connection of Sir G. G. Stokes with the Society. The following are amongst those who formally communicated papers:—

I. By Prof. M. G. Mittag-Leffler: On the analytical representation of a uniform branch of a monogenic function.
II. By Prof. H. Poincaré: The theory of groups.
III. By Dr. L. Boltzmann:
IV. By Prof. A. Righi:
V. By Prof. A. A. Michelson: On the echelon spectroscope.
VI. By Major P. A. Macmahon, R.A.: Application of the partition analysis to the study of the properties of any system of consecutive integers.
VII. By Lord Kelvin: On diffraction of solitary waves.
VIII. By Prof. A. Schuster: On the periodogram of magnetic declination derived from twenty-five years' observations at the Greenwich Observatory.
IX. By Prof. W. D. Niven: A general method of determining free electric distributions by successive approximations.
X. By Prof. G. D. Liveing: The influence of temperature on the absorption spectra of salts.
XI. By Prof. A. R. Forsyth: On the integrals of systems of differential equations.
XII. By Mr. J. Larmor: On the general theory of the optical relations of magnetism.

Together with papers by Prof. J. J. Thomson, Dr. E. W. Hobson, Mr. E. H. Griffiths, Mr. W. N. Shaw, Mr. E. W. Brown, and Mr. H. M. Macdonald.

In conclusion, it may be stated that from beginning to end the celebration was a complete success. The weather played an important part in securing this success, but the thanks of all who assisted at the jubilee must also be tendered to those at Cambridge who took such careful forethought for their convenience and comfort.

The Cambridge Review for June 1 publishes several contributions referring to the jubilee, and issues as a special supplement an excellent portrait of Sir George Stokes. Prof. J. J. Thomson gives an appreciative account of the scientific career and work of the esteemed Lucasian Professor. In concluding the article, he remarks:—

"By his researches on hydrodynamics he has founded a new branch of the science; in optics he has, to use the words of Lord Kelvin, been the teacher and guide of his contemporaries; he was the first to enunciate in his lectures the principles on which spectrum analysis is founded; he unravelled the laws of fluorescence; he investigated the variation of gravity over the surface of the earth; he has solved problems of the greatest difficulty in pure mathematics; while the latest of his long series of researches is his remarkable paper on the nature of the Röntgen rays. His papers are the classics of science; they are remarkable, not only for the results obtained, but also for their perfect clearness of expression and thought, for the elegance of the mathematical methods, for their maturity of judgment and for that care and finish on which so much of the impressiveness of a paper depends.

The little more and how much it is,
The little less and what worlds away.

These researches show the combination of supreme mathematical and experimental power; with simple apparatus and without the appliances which are now at the command of physicists, he has made experiments which have settled some of the most crucial points in optics, and which will be quoted as long as science exists. The rooms in Pembroke, where he made many of his experiments, will in the history of science and of the University be associated with those in the Old Court of Trinity, where Newton made the prism reveal the nature of white light. And, indeed, there are many points of resemblance between the careers of Newton and of Stokes: both held the Lucasian Professorship, both were Presidents of the Royal Society, both represented the University in Parliament; and the resemblance is not confined to the offices they held, it extends to their type of mind. Often, in reading Stokes's papers, we feel this is just how Newton would have treated this point, these are the deductions which Newton would have drawn."

Prof. Jebb contributes the following ode to the *Cambridge Review*.

TO SIR GEORGE GABRIEL STOKES.

JUNE 1, 1899.

Clear mind, strong heart, true servant of the light,
True to that light within the soul, whose ray,
Pure and serene, hath brightened on thy way,
Honour and praise now crown thee on the height
Of tranquil years. Forgetfulness and night
Shall spare thy fame, when, in some larger day
Of knowledge yet undream'd, time makes a prey
Of many a deed and name that once were bright.

Thou, without haste or pause, from youth to age,
Hast moved with sure steps to thy goal. And thine
That sure renown which sage confirms to sage,
Borne from afar. Yet wisdom shows a sign
Greater, through all thy life, than glory's wage;
Thy strength has rested on the Love Divine.

CENTENARY OF THE ROYAL INSTITUTION.

THE celebration of the centenary of the foundation of the Royal Institution was commenced on Monday by a banquet given by the managers of the Institution in the Hall of the Merchant Taylors' Company. The Duke of Northumberland, president of the Institution, occupied the chair. The Prince of Wales was present, and a number of distinguished men of science were among the guests. Reference to a few points connected with the history and work of the Institution were made in the course of the evening. In acknowledging the toast of his health, the Prince of Wales said:

I consider it a great privilege and honour to take part, as vice-patron of this Institution, in the celebration of its 100th anniversary. I had an early acquaintance with the Royal Institution. Although it is nearly half a century ago, I have not forgotten that just after Christmas my brother, the Duke of Coburg, and myself were sent to attend the lectures given by the great Prof. Michael Faraday. I have not forgotten the clear way in which Prof. Faraday explained difficult scientific problems, and showed the chemical experiments which were then the order of the day. Among the most remarkable discoveries with which the Institution is associated is that of Davy, which has saved thousands of lives. It is needless to speak of the researches of Faraday, whom I knew; and in our own time of the remarkable achievements in several branches of science of Lord Rayleigh. I thank you once more most cordially, and express my high appreciation of this great and important centenary event. I am glad also to see so many distinguished foreigners who have come over to take part in this interesting gathering.

The Duke of Cambridge proposed "The Royal Institution of Great Britain," and in doing so remarked that the declared object of the Institution was the diffusion of knowledge and the

introduction of useful mechanical inventions, and the means were to be courses of philosophical lectures and experiments illustrating the applications of science to daily life.

The Chairman, in acknowledgment of the toast. said that it was a great honour that so many eminent representatives of foreign science had honoured with their presence the centenary of the Institution. It was just 100 years ago when the Institution entered upon its present premises. A long roll of names had lent lustre to their labours. Davy, Faraday, Young, Tyndall—above all, they should remember their founder, Benjamin Thomson, Count Rumford, whom it was easy to criticise, but whose virtues had been productive of great results. The work of the Institution had been in large measure the carrying out of Count Rumford's ideas. It was said that he intended an institution of a more practical or industrial character than the Institution now was. But changes had taken place. Facilities for communicating new discoveries were 100 years ago few; competition was less keen; there was then much dislike of innovation, and there was extreme jealousy with the working classes of any reduction of manual labour. It was thus necessary to popularise discoveries; and that was the aim of their founder. But now every such discovery was soon heralded to the public. Popular magazines had now articles on the manufacture of liquid air and other subjects of an abstruse character. Towards this wide diffusion of science the Royal Institution had largely contributed. Their principal objects were research, for which their laboratories gave ample means, and in respect of which special gratitude was due to Dr. Mond for his noble gift, and to Mr. Spottiswoode for his collection. The second object was to bring the results of research to the knowledge of those who could appreciate them, and these results were expounded in the evening lectures of the Institution. Thirdly, this knowledge was popularised by the afternoon lectures; and, finally, the rising generation were stimulated by the juvenile lectures to those who, it was hoped, were destined to take their part in future scientific investigation.

On Tuesday afternoon a commemoration lecture was delivered at the Institution by Lord Rayleigh, the Prince of Wales being present.

In the course of his remarks, Lord Rayleigh is reported by the *Times* to have said that though his was intended to be a commemorative lecture, the idea of commemorating all the work that had been done at the Royal Institution was hopeless. Remembering that on other occasions he had spoken of the achievements of Faraday and Tyndall, he thought on this occasion he would do well to go still further back in the century and speak of Dr. Thomas Young, one of the earliest professors of the Institution. Young occupied a very high place in the estimation of men of science—higher, indeed, now than at the time when he did his work. His "Lectures on Natural Philosophy," containing the substance of courses delivered in the Institution, was a very remarkable book, which was not known as widely as it ought to be. Its expositions in some branches were unexcelled even now, and it contained some things which, so far as he knew, were not to be found elsewhere. The earlier lectures dealt with mechanics, and the reader would find as sound an exposition of that science as could be imagined. Elastic resilience, or what we should now call potential energy, was better dealt with there than in any other treatise he knew, for Young discussed the subject with remarkable ingenuity, showing that the phenomena exhibited by two bodies coming into collision were comprehended under two cases. In the province of sound, Young was the originator of many of the most important principles on which the doctrine was now expounded, but it was with optics that his name was most closely associated, for Fresnel and he were the builders of the great structure of the undulatory theory. Lord Rayleigh then mentioned some of the points in which Young's good work had been overlooked. In Young's time one question of discussion was the change of the focus of the eye for varying distances. One suggested explanation, that accommodation was affected by an alteration in the external convexity of the eye, Young proved to be wrong by drowning his eye in water. This virtually altered the convexity, yet the power of accommodation remained, and he therefore concluded it was due to a muscular alteration in the internal lens of the eye. Young was singularly successful in the theory of cohesion and capillarity, in which some of his earliest work was done, and he was the first to deduce an estimate of molecular dimensions from data afforded by that theory. The size of the molecule, according to his calculations, was not very different from that admitted at the present day. In the theory of the tides he made great advances, while his views on heat were very interesting, since he had the utmost contempt for the idea prevalent in his time that it was a separate entity, and expressed the hope that in time philosophers might arrive at a true conception of its nature as motion. Speaking of work which had been done at the Institution by men who held no regular appointment in it, the lecturer noted that Wedgwood, in conjunction with Davy, was the first to produce anything that could be called a photograph, while instantaneous photography, such as was required for rapidly moving objects, was carried out for the first time by Fox Talbot in the laboratory of the Institution.

Another commemoration lecture is to be delivered as we go to press. Upon the invitation of the teachers of natural science in Oxford University, honorary members of the Institution will visit the University to-day.

The principal historical apparatus in the Institution has been on view during the centenary celebration. An interesting souvenir of the centenary is an illustrated brochure referring to William Spottiswoode, and to his collection of physical apparatus just presented to the Institution by his son, Mr. W. H. Spottiswoode. The souvenir includes a memoir of Spottiswoode, reprinted from NATURE of April 26, 1883; a list of lectures delivered by him at the Royal Institution, notes on some of the more important objects in the collection of apparatus, a reprint of a paper by Spottiswoode on the laboratories of the Institution, and a chronological list of original work developed at the Institution. A photogravure of Spottiswoode, and a number of brilliant half-tone pictures of sets of objects in the collection of apparatus, form part of Mr. Spottiswoode's interesting pamphlet.

THE HEIGHT OF THE AURORA.[1]

A GOOD story used to be told some years ago of a candidate, who, when undergoing the torture of a *vivâ voce* examination, was unable to reply satisfactorily to any of the questions asked. "Come, sir," said the examiner, with the air of a man asking the simplest question, "explain to me the cause of the aurora borealis." "Sir," said the unhappy aspirant for physical honours, "I could have explained it perfectly yesterday, but nervousness has, I think, made me lose my memory." "This is very unfortunate," said the examiner, "you are the only man who could have explained this mystery, and you have forgotten it." One is not prepared to say that exact and complete knowledge of the cause of this curious phenomenon has greatly advanced since the time when the examiner made this crushing rejoinder, and it is therefore fortunate to have to treat of only one of the difficulties with which the whole problem is beset—the height at which the light manifests itself, or the limits of altitude above the earth's surface at which it may be seen. But a preliminary difficulty arises in connection with even this bare statement. Is the aurora borealis a localised phenomenon? Has it a habitation as well as a name? Or is it, like the rainbow, an optical exhibition resulting from the operation of certain physical causes. In the case of the rainbow, the causes admit of a tolerably simple explanation, and little is to be learnt from the study of its general features as seen in the sky; certainly we should not think it betokened any great show of wisdom to attempt to determine its height by any method of measurement or triangulation. The angular altitude is settled for us in a quite different manner, and it may

1 "The Altitude of the Aurora above the Earth's Surface." By Prof. Cleveland Abbe. ("Terrestrial Magnetism," vol. iii., 1898.