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1901.

ANNUAL GENERAL MEETING

HELD AT THE HOUSE OF THE SOCIETY OF ARTS, MONDAY, JUNE 10, 1901.

The President,
Sir GEORGE GABRIEL STOKES, Bart., LL.D., Sc.D., F.R.S.,
IN THE CHAIR.

The PRESIDENT.—Ladies and gentlemen, a telegram has been received from General Sir H. L. Geary regretting that he is unable to attend, and letters have been received from Captain Creak and Mr. Howard also expressing their regret that they are unable to attend the Annual Meeting.

I will now ask the Secretary to read the Report.

The Secretary, Professor EDWARD HULL, M.A., LL.D., F.R.S., read the following Report of the Council :—

1. In presenting the THIRTY-FIFTH ANNUAL REPORT, the Council has the pleasure of stating that the position of the Institute has been fairly well maintained during the past year, both as regards membership, the character of the communications read at the Ordinary Meetings, and the funds. The Institute has not been free from "those adverse influences" referred to in the previous Report, which have caused some Members and Associates to retire from their connection with it—due to increased demands on their income; and this influence has especially affected the parochial clergy. But in nearly every case where such withdrawal of support has been rendered necessary, the notice of resignation has been accompanied by expression of sincere regret, and of continued interest in the work carried on by the Institute itself. It were much to be desired that there was some fund available from which the Council could assist such persons in retaining their connection with the Institute.

2. The Institute would be greatly aided if individual Members or Associates would endeavour to interest their friends at home, abroad, or in the Colonies in its work. A large proportion of our constituents reside outside the British Isles, especially in America and India; and the *Annual Journal of Transactions* serves as a bond of sympathy with this country, and from the variety of subjects discussed in its pages, serves to interest them in many of the problems of the day.

3. The following is the new list of the Officers and Council:—

President.

Sir George Gabriel Stokes, Bart., LL.D., Sc.D., F.R.S.

Vice-Presidents.

The Rt. Hon. the Earl of Halsbury, P.C., F.R.S., The Lord High Chancellor.
The Ven. R. Thornton, D.D., *Archdeacon of Middlesex.*
Sir Joseph Fayrer, Bart., K.C.S.I., F.R.S.
Sir T. Fowell Buxton, Bart., K.C.M.G., F.R.G.S.
Alexander McArthur, Esq., J.P., D.L.
W. H. Hudleston, Esq., M.A., F.R.S.
Professor Lionel Beale, F.R.C.P., F.R.S.
The Most Rev. the Archb. of Armagh, D.D.

Trustees.

D. Howard, Esq., D.L., F.C.S.
Rev. Preb. H. Wace, D.D.

Hon. Auditors.—J. Allen, Esq.; General G. S. Hallowes.

Council.

Hon. Treasurer.—Lieut.-General Sir H. L. Geary, K.C.B.
Sec.—Professor Edward Hull, LL.D., F.R.S.

His Honour Judge Waddy, K.C.
Rev. J. H. Rigg, D.D.
H. Cadman Jones, Esq., M.A.
Rev. W. Arthur.
Rev. J. Angus, M.A., D.D.
*D. Howard, Esq., D.L., F.C.S.
Rev. F. W. Tremlett, D.D., D.C.L., Ph.D.
*Rev. Preb. H. Wace, D.D.
Rev. Chancellor J. J. Lias, M.A.
*Gen. G. S. Hallowes.
Capt. Creak, C.B., R.N., C.B., F.R.S.
Rev. F. A. Walker, D.D., F.L.S.
T. Chaplin, Esq., M.D.
Rev. Canon Girdlestone, M.A.
T. G. Pinches, Esq., LL.D., M.R.A.S.
The Ven. Archdeacon Sinclair, D.D.
Dr. Gerard Smith, M.R.C.S.E.
Commander G. P. Heath, R.N.
Rev. Canon Tristram, M.A., D.D., LL.D., F.R.S.
Rev. G. F. Whidborne, M.A., F.G.S., F.R.G.S.
General Sir H. L. Geary, K.C.B., R.A.
Count Della Rocchetta.
Dr. Walter Kidd, F.Z.S.
E. S. M. Perowne, Esq.
M. L. Rouse, Esq., B.L.
Rev. R. A. Bullen, B.A., F.G.S.
Rev. John Tuckwell.

* *Ex officio.*

4. The Council regret to announce the decease of the following supporters of the Institute, among whom were many exceptionally prominent men in varied spheres of usefulness:—

Sir H. W. Acland, Bart., K.C.B., *M.*; Rev. T. B. Angell, *A.*; Rev. H. R. Bailey, M.A., *A.*; W. Bickford-Smith, Esq., *M.*; Rev. R. Collins, M.A., *M.*; Rev. R. Cooper, M.A., *A.*; John Deacon, Esq., *L.M.*; W. Forsyth, Esq., LL.D., Vice-President; the Hon. H. D. Ryder, Earl of Harrowby, *L.M.*; Rev. S. H. Kellogg, D.D., *A.*; John Napier, Esq., *M.*; Rev. A. Peache, D.D., *A.*; Capt. F. W. H. Petrie, late Hon. Sec.; E. Quaile, Esq., *A.*; C. K. J. W. Tyndall, Esq., *A.*; William Vanner, Esq., *M.* (Member of Council); A. G. Yeates, Esq., *M.*

5. The following is an approximate statement of the constituency of the Institute at the end of May, 1901:—

Life Members	.. .. ..	44 in number.
Annual „	.. .. ..	197 „
Life Associates	.. .. ..	64 „
Annual „	.. .. ..	480 „
Hon. Corresponding Members	..	183 „
Total	..	968

The Council hope that during the coming year an effort will be made to bring the adherents up to the number of one thousand. In this connection Members are reminded that payment of the entrance fee of one guinea is temporarily suspended.

6. *Finance.*

The Treasurer's Balance Sheet for the year ended December 31, 1900, duly audited, shows the total receipt of £1,171 19*s.* 10*d.*, leaving a balance of £18 3*s.* 7*d.* to credit of the Institute. The Reserve Fund of 2¾ per cent. Consols has been reduced by £200, which was sold out in order to meet the unusually heavy charge on account of printing. In order to bring this item of expense within more moderate limits, the Council decided to discontinue the issue of the quarterly numbers of the Journal.

Special.—The Council desires to urge the great importance of all subscriptions being remitted during the first half of the year (Bye-law III, 3 and 4). Adherence to this rule will facilitate the work of the Institute, and help towards removing any cause of anxiety to the Council. Forms for the payment of the subscriptions through a banker are used by a large number of Members and Associates, and may be had at the office.

7. MEETINGS.

The meetings of the Institute have been generally well attended, and the subjects dealt with have been of a varied character, as will be seen by the following programme. The subjects may be arranged under the following heads:—

1. HISTORY.

"Report on the Proceedings of the Congress for the History of Religion," Paris. By THEOPHILUS G. PINCHES, LL.D., M.R.A.Soc.

"The Wahabies." By Rev. S. M. ZWEMER, F.R.G.S.

"The Maoris' Place in History." By JOSHUA RUTLAND, Esq.
"The Arab Immigration into South-east Madagascar." By Rev. G. A. SHAW, F.Z.S.

2. ZOOLOGY.

"Notes on Hornets and Grasshoppers." By Rev. F. A. WALKER, D.D., F.L.S.

3. GEOLOGY.

"Evolution from a Geological point of View." By Rev. G. F. WHIDBORNE, M.A., F.G.S.
"Time Divisions of the Ice Age." By WARREN UPHAM, Esq., F.G.S.Amer.

4. GEOGRAPHY.

"Visit to the Hittite Cities, Eyuk and Boghaz." By Rev. G. E. WHITE, Marsovaen.
"Ancient Script in Australia." By E. J. STATHAM, Esq., C.E.

5. ART.

"The Relation of Religion and Art." By Rev. T. HUNTER BOYD.
"The Sacrament of Divine Art." By ERNEST NEWLANDSMITH, Esq.

The "ANNUAL ADDRESS," by Sir ROBERT S. BALL, LL.D., F.R.S., Professor of Astronomy, Cambridge University, on "The Origin of New Stars," to be delivered this afternoon.

8. *The Journal of Transactions.*

The King, following the custom of Her late Majesty, His illustrious mother, has been graciously pleased to add the last volume of the *Transactions* to the Royal Library.

The thirty-third volume of the *Journal of Transactions* will shortly be issued. It will contain the subjects brought before meetings of the Institute and discussed, together with the communications received from Members in the country and abroad, who have added to the value of those discussions by sending in communications on the subjects considered.

The careful correction of the papers, discussions, and communications, by their respective authors, often involving repeated communications even with distant lands, and references to the views of other investigators who have made the subjects treated matters of research, is at times a cause of delay in the publication of the Journal containing them, but the result is to give the Volume of Transactions the character of a finished work. From time to time Members of the Institute and others have expressed their high sense of the value of the Transactions of the Institute, inasmuch as they *contain, not the views of any one person only, but the well-considered opinions of many*, resident in various and even distant parts of the world. This system gives a

value to the treatment of the several subjects beyond that which any individual author could give.

9. *Spread of the Work and Useful Influence of the Institute.*

Not many years ago the issue of the Annual Volume was considered to complete the work of the Institute, but of late the wish to make further use of the matter it contains has had valuable results:—

First;—Members and Associates at home, in India, and elsewhere, make use of the papers in the Journal as lectures, or as the basis of such, in their several localities.

Secondly;—Some Members and Associates secure the translation and circulation of portions of the Journal in the various countries in which they reside. Such translations have been made in many countries of Europe, South America, and India; and now from China and Japan, the importance of securing translations has been strongly urged.

Thirdly;—Some home, foreign, and colonial public libraries and institutions are regular purchasers of the Journal, and Members and Associates have sought to encourage this practice in their respective localities. The need of so doing has been pointed out by many Members, since it is by no means unusual, especially in the Colonies, to find in public libraries books arguing that Science and Revelation are at variance. The Journal of the Institute has been spoken of as specially suited as a corrective to such erroneous views. In India and elsewhere some have obtained the Journal or copies of the People's Edition, and placed them in local reading rooms for the use of English-speaking natives and others.

10. *Accession of King Edward VII.*

The Council of the Institute was not less desirous than other learned Societies to testify its sorrow upon the death of our late Queen, and to offer to His Majesty Edward VII the assurance of devotion and loyalty to the Crown and Person of His Majesty. In accordance with this desire a dutiful and loyal address to the King was adopted at the meeting of the Council on Monday, 4th February, and afterwards read at the meeting of Members and Associates by the President; and forwarded through the Home Secretary to His Majesty, by whom a gracious reply was returned, which was read from the Chair at the meeting held on April 1st in the rooms of the Institute.

11. *The People's Edition.*

This consists of twelve papers—written by men of eminence in such a style that they may be comprehended by all—reprinted from the *Journal of Transactions*. The Edition was started by some Members in the year 1873, and first attracted attention in other quarters to the importance and need of works of the kind. The pamphlets often contain the objections and criticisms brought forward in discussing the subjects, as many home and foreign correspondents have urged the value of including these. They are published in neat covers, and are sold at a nominal price (sixpence), and single copies are supplied *gratuitously* or at cost price, at the office, to all individual lecturers against infidelity, including those of the London City Mission, the Christian Evidence Society, and similar bodies.

12. *The Gunning Fund.*

This fund was founded by His Excellency Robert Halliday Gunning, M.D., LL.D., F.R.S.E., etc. It at first consisted of a bond of £500, the interest on which was paid by Dr. Gunning to further the work of the Institute. The Executors have now paid the money to the Trustees of the Institute; and the amount is lodged with the bank on deposit receipt pending its investment. A Sub-Committee has been nominated by the Council for the purpose of drawing up a scheme for founding "a triennial prize," in accordance with the will of the founder, and in harmony with the constitution of the Institute;—a matter which will require careful consideration, and which may not be definitely arranged for some time.

13. *Conclusion.*

In conclusion the Council desires to express its thankfulness for the success thus far of the Institute.

The importance of its work has been recognized by loyal support from its Members in all lands. They realise that an Institute conducted by such men as the President of the Institute (Sir G. G. Stokes), the Lord High Chancellor of England (Earl of Halsbury), Lord Kelvin, and other leaders of thought, devoting their time voluntarily to carrying on the Institute's work, is one which is potent for good results in banishing that spirit of unbelief which has professed to be founded on science.

G. G. STOKES.

ANNUAL BALANCE SHEET, *from 1st January to 31st December*, 1900.

RECEIPTS.

	£	s.	d.	£	s.	d.
Balance from 1899				133	19	3
Subscriptions :—1 Member, 1897	2	2	0			
2 Members, 1898.. ..	4	4	0			
7 „ 1899.. ..	14	14	0			
152 „ 1900.. ..	319	4	0			
3 „ 1901.. ..	6	6	0			
5 Entrance Fees.. ..	5	5	0			
1 Associate, 1894 ..	1	1	0			
1 „ 1895 ..	1	1	0			
3 Associates, 1896 ..	3	3	0			
3 „ 1897 ..	3	3	0			
10 „ 1898 ..	10	10	0			
28 „ 1899 ..	29	8	0			
348 „ 1900 ..	365	8	0			
15 „ 1901 ..	15	15	0			
1 „ paid short..	1	0	0			
				782	4	0
Dividend on £1,165 18*s.* 9*d.* 2¾ p.c. Consols				34	13	8
Donation to Special Fund (H. C. Dent, Esq.)				1	1	0
Sale of Journals				23	12	11
Sale of Consols (Reserve)				196	9	0
				£1,171	19	10

EXPENDITURE.

	£	s.	d.
Printing	436	0	3
Postage	54	0	6
Binding	22	10	4
Reporting	29	8	0
Typewriting	0	15	9
Stationery	21	9	2
Advertising	7	9	6
Expenses of Meetings	11	2	6
Travelling	5	18	10
Clerk—Salary	84	10	0
„ Extra	28	12	0
Rent	180	0	0
Housekeeper	0	15	0
Coal and Light	8	17	1
Library	14	4	1
Late and Present Secretaries	235	0	0
Insurance	0	12	0
Bank Charges	0	18	6
Sundries	9	10	9
Subscriptions repaid	2	2	0
Balance Cr.	18	3	7
	£1,171	19	10

There is a reserve fund of £1,165 18*s.* 9*d.* New 2¾ °/₀ Consols.

We have examined the Balance Sheet with the Books and Vouchers, and find a Balance in hand of £18 3*s.* 7*d.*

JOHN ALLEN,
G. S. HALLOWES, Major-Gen., } *Auditors.*

26 March, 1901.

Rev. Dr. IRVINE, F.G.S.—Mr. President, ladies and gentlemen: By accident your Secretary has requested me to move the adoption of this admirable Report since I came into the room. I suppose he fixed on me by a kind of instinct of fraternity. We have together, in former years, hammered the rocks—especially in the sunny south-west of that glorious county of Devonshire. So I cannot, for a moment, hesitate to accept that responsibility which your Secretary wished to thrust upon me. Not that I feel that that responsibility is a great one, because no advocacy is required, I think, to recommend this Report to the minds of all present, and to all who are interested in this Institute and the noble work it is carrying on. I look upon this Institute as something unique. It is a learned Society and something more. It is, as it were, a nucleus for the fraternization of all learned Societies and for all those engaged in learning—not scientific only, but literary and historical, and everything which tends to throw light on progress and the welfare of the human family; and to elucidate the beneficent workings of Divine providence. So I am sorry to see one statement in the Report, which announces the loss of so many clerical members of the Institute. Let us hope it will be only a temporary relapse, for I think the Institute has done in this way somewhat of the work which the great Oxford Reformers did for us when they advocated greater learning, a wider range of studies and a severer intellectual discipline for the clergy of the Church of this country. Therefore I have very great pleasure, and I count it a great honour to be called upon, to move the adoption of this Report.

The Ven. Archdeacon THORNTON, D.D.—Mr. President, ladies and gentlemen: A long speech is not wanted in seconding the resolution which has been proposed to you. The Report which has been read to us, or partially read to us, appears to be a satisfactory one, and shows that while the Institute is doing its work in various departments of science, it is possible to be deeply scientific and at the same time deeply religious.

I sincerely hope, if the number of Members and persons interested in the Institute be raised to the round "one thousand," which the Secretary expressed his hope it would be, that this difficulty will be removed and that the £200 which has been taken away from the reserve fund will be replaced by £300. I beg to second the adoption of the resolution.

The PRESIDENT.—Before putting this motion, I will just make one remark. Although it would appear from the balance sheet as if we had been rather going down hill, it is more in appearance than in reality. I think our late Treasurer, who is to be replaced by another to-day, will be able to say a word or two in explanation of that.

The SECRETARY.—In the absence of the new Treasurer I may state what the President has said is quite correct. The actual income has not been less than last year—possibly a little more: but it would be impossible to go into details on the present occasion.

The PRESIDENT.—Before I put this to the vote I may remark that some of the officers of the Society have been changed, *i.e.*, new names have been introduced, viz.—Sir T. Fowell Buxton, Bart., and Professor Lionel Beale as Vice-Presidents. There are three new members of Council—E. S. M. Perowne, Esq., Martin L. Rouse, Esq., and the Rev. R. A. Bullen.

According to the rules of the Association the Anniversary Meeting is the proper time for the election of officers.

The motion is that the Report of the Council now read be received and adopted and circulated amongst the Members and Associates.

The resolution, having been put to the meeting, was carried *nem. con.*

I will now call on Dr. Clapton to move the next resolution.

Dr. CLAPTON, F.L.S.—I beg to move that the thanks of the Members and Associates be presented to the Council, the Hon. Officers and Auditors for their important services during the past year. I am sure that those who have attended the meetings this year will heartily support this resolution, which I have much pleasure in moving.

Professor ORCHARD.—I have very much pleasure in seconding that resolution. It requires no seconding, because the Council and officers are really the people who have brought this Institute to its present state of efficiency.

The PRESIDENT then put the resolution, which was carried unanimously. He then called on Sir Robert Ball, LL.D., F.R.S., Lowndean Professor of Astronomy in the University of Cambridge, to deliver the Annual Address, "The Origin of New Stars."

THE ORIGIN OF NEW STARS.

By Prof. Sir ROBERT S. BALL, LL.D., F.R.S.

MR. PRESIDENT, LADIES AND GENTLEMEN,—The subject of the address that I propose to give you is "The Origin of New Stars," and the title was naturally suggested by that very remarkable star—the most remarkable of its kind which has appeared for three hundred years—at which we all looked with such interest in the early months of this year.

But I am taking the opportunity to refer to the subject also in a somewhat wider manner—to speak of those processes of change and transformation which we observe actually going on at this moment in the universe around us.

First of all as to what we mean by new stars. We look up into the heavens at night and see constellations, and history tells us that those constellations were the same in the days of Homer, and in the days of Job, practically, as they are at present. But we must not imagine that those constellations, and those arrangements of stars are eternal; for, as Professor Hull tells us, the mountains and other features of the earth have been in constant change during the course of geological time, though those changes are not appreciable in historic times; and in like manner these constellations of the sky are not always the same. It is very easy to show that within such a period of time as may be comparable with geological periods, the whole face of the skies, too, will have undergone a complete transformation. We have all seen in museums the ichthyosaurus, the eye of which is a most remarkable optical instrument; but if that animal could ever have glanced up to the skies I think I shall be justified in saying that not a single one of those stars that we now see were then within his ken. The heavens have gradually changed, and in the course of a certain period of time—say ten million years, from what we know of the movements of the stars, there would doubtless be a complete transformation; so that the stars which we see about us now, that may be unchangeable from our ephemeral point of view, are in a state of gradual change. When coming down Channel you see a number of ships about; you do not see much motion in them, if you look again, in

another hour you still see a number of ships about, but they are not the same ships that you saw before. So in the heavens there is a continual flux. The old stars are passing away, and new stars are coming into view.

I will try to illustrate the appearance of this new star—the way in which it came, and the evidence we have of its character. I am fortunate to be able to do this, for by the kindness of friends I have obtained the use of photographs which will show us the peculiar circumstances which mark that star from all other ordinary stars, even if we had not the remarkable circumstances in connection with its sudden outbreak and its still more remarkable decline. I will now ask for the lights to be turned down for a few minutes while we look at the pictures thrown on the screen.

[*A picture was then exhibited.*]

That is merely a picture of a small part of the skies—not the whole heavens—not more than a one ten-thousandth part of the heavens. It is a very rich part of the Milky Way, containing innumerable myriads of stars. There is no spot on that diagram upon which I could place the tip of my finger without hiding some star behind it. We take that as an example of the starry firmament as we see it.

Now we will look at another, giving us a view of a different part of the heavens.

[*Exhibited on the screen.*]

It would take ten thousand such pictures as you are looking at to cover the whole stars of the heavens, and here, again, there are innumerable myriads of them, and in view of what is to come, I will ask you to retain a general impression of this picture in your minds.

Now we come to a much more special picture.

[*Exhibited on the screen.*]

This was given to me by Mr. Stanley Williams, and it represents a photograph of a part of the sky on February 22nd. That picture represents all those stars which have, no doubt, been there for thousands of years, and then, a week later, he took *this* second picture and this is the new star which appeared in the meantime.

[*Exhibiting on the screen.*]

It shows the sudden way in which that new star burst into view. It greatly increased in lustre until it exceeded,

for a short time, any other star in the northern sky, and then there set in a decline and the star got gradually fainter. It did not go out entirely, but declined, and then every now and then there was a recrudescence. Sometimes the star could not be seen and sometimes it could. It suffered remarkable fluctuations in brightness and then gradually declined, and it had sunk down to a faint star when last seen before the advancing daylight extinguished it.

Now what is the origin of such a star as that? Let us first consider what the stars are. This is a question which depends very much on heat, or the degree of capacity for radiating heat and light that the stars present. Will you imagine this stick to be a thermometer with a long graduated scale, and where I hold my finger to represent the temperature of the bodies when red hot; when you can just see them. Up about *here* would be the temperature of bodies when they would be as hot as suns; and below would be a very cold temperature—the temperature of space. Such a temperature as this Professor Dewar has shown us by his most remarkable researches to be that at which air freezes to a solid lump. Below the point corresponding to redness an object sends no light that can make it visible, but above that it sends light which will make it visible according to the degree of brightness and other circumstances. I exclude the moon and the planets for the moment. Jupiter is only bright because it reflects back to us a little sunlight. Were Jupiter to pass out to where the stars in that picture are, you would not see it at all; and all the objects we see in the heavens, excluding the planets, are objects which shine by their own light. They are objects of which the temperature would be on *this* part of the scale, above the red line. But the simplest consideration shows us that every hot body tends to get cold, and every one of those objects that we look at is radiating its heat, and is generally tending to cool, and consequently, tending to come down and pass this line. When once they get down there they may stay at that temperature to all eternity, unless some tremendous change takes place to bring them up again. There is a general tendency of bodies in space to come down to the colder temperatures. When we look up at the heavens above and their myriads of objects, we must remember that we only see the bright objects, the dark ones are invisible. The earth only has a two-thousand millionth part of the light from the sun, and therefore you

see that these stars, or sunlighted bodies and planets around them, only get a two-thousand millionth part of the light and are not seen. The brilliant objects that we see, though they are overwhelmingly numerous, yet they must be absolutely as nothing in comparison with the myriads of dark objects which are totally invisible to us, except when certain very remarkable circumstances arise. The probability is, when we look at the stars, we do not see a thousandth, part of the actual amount of matter up there, because it is much more usual for a body to be dark than it is for that body to be bright. Brightness is a temporary stage, and darkness is a stage of indefinitely long duration.

When we look up at the heavens, I sometimes think that the view we get may be paralleled with that a being from some other part would get of this city of London if, instead of looking at us in daylight, he came and stood on the Monument, at night, and looked down on the sleeping city. What would he see? He would not see the buildings, and of the wondrous life of that city he would see nothing—merely lights here and there dissipating the gloom slightly. If that being were to go away thinking he had seen London, simply because he had seen those lights, how very inadequate would be his knowledge. In a somewhat similar way we must interpret the lights in heaven. It is the dark things that are most numerous, and we have only become acquainted with a very few. Occasionally it happens that by some remarkable incident in the heavens, the dark objects, or some of them, become known to us. We are no longer left merely to conjecture as to their existence, but they became actually apparent; and such an instance we found in that new star which broke out last February in the constellation of *Perseus*. For the examination of stars in these modern days, methods are provided by the spectroscope. We now analyze them in a way which was impossible before the spectrum analysis was available. I will illustrate this by showing some photographs that were taken by Father Sidgreaves of Stonyhurst College, to whose kindness I am so greatly indebted.

I had the privilege of looking at the spectrum of this new star in *Perseus*, and it was a most striking sight. If there were nothing else than that spectrum, if nobody knew anything further about the history of the star he would at once have said, "Surely this is a star of the most remarkable character and quite unlike ordinary stars"; for there are

several brilliant lines crossing the spectrum. Here we get nature to speak for herself—we are looking at the actual photographs. In these days there is no excuse for giving illustrations which are not absolute photographs.*

The spectroscope shows in *Nova Persei* the presence of a great mass of blazing incandescent hydrogen, and when you accompany this with the fact that the star suddenly broke out and declined again, it becomes of great interest indeed. I pointed out this statement how in the spectrum of this star the dark lines and bright lines of hydrogen are close side by side. It would take too long to go into more detail; but there is no doubt, from the evidence that these photographs contain, that there were two bodies concerned. Those two bodies were moving with different velocities. The dark line belongs to one and the bright line (speaking generally) may be said to belong to the other. Taking that into account, and taking into account the suddenness of its outbreak, and the indications of blazing hydrogen, it is quite easy for us to form a supposition, which is not an unnatural one, as to what was the cause of that remarkable star. I mentioned that, of the stars above us, the dark stars are in all probability incomparably more numerous than the brilliant ones. We do not see those dark stars under ordinary circumstances; but, in their myriads, it does sometimes happen that one of those dark stars, hurrying along, comes into collision with another. I have no doubt that the occurrence of such a collision is excessively rare. We must remember that these bodies are moving at enormously high velocities in vast numbers, and there is just a possibility of two of them striking. It is not unlike supposing that two rifle shots fired at random, in the air, should strike in the course of their flight. I need not tell you that if one man were firing a rifle in one place and another man a mile away were firing in an opposite direction, that it is most unlikely the two bullets should strike each other. If myriads of rifle bullets were being fired in every sort of direction then it would be conceivable that some pair of those bullets would strike each other. It is not so very unlikely—in fact there is the very best reason for believing that it may sometimes happen. I believe it is recorded that on a field of battle one rifle bullet has been known to pierce another. I think I have

* For spectra of Nova Persei, 1901, see "Observations on the star of Nova Persei," by Sir Norman Lockyer, *Proc. Royal Society* for Feb. 28, March 7, and June 20, 1901.

seen a photograph of such a remarkable coincidence having occurred. So it seems to have happened in this instance, that two of the dark bodies in space have come together. They need not have been very large bodies. The probability is that they were not very large bodies. Also it is not necessary to suppose that they came actually square together. It may have been hardly a collision at all—a mere grazing collision. If they came excessively close it is conceivable that the blow would produce a tremendous amount of friction, and it would develop a considerable quantity of heat. It may be said, "Yes, but if they come together at a temperature so cold as that at which we know even air itself is a solid lump, is it conceivable that the mere knocking together of those two bodies can create a temperature so great as to render incandescent those vast bodies of hydrogen, whose light is radiated millions and millions of miles throughout the universe?" A few figures will show that it is conceivable this might take place.

I am not going to trouble you with more figures than are absolutely necessary. You remember that a rifle bullet when fired from a rifle and hitting a target, is warm when it is picked up. That warmth is due to its motion being stopped by the blow against the target. If a body moving at a velocity far faster than that of a rifle bullet strikes against another, the heat developed in that body would be greater still. Take a piece of coal and suppose it to be sent through space at a velocity of five miles a second—ten times the velocity of any bullet fired from a rifle, then that piece of coal, if it struck against a wall, or came into collision with another piece of coal travelling in the opposite direction, would develop from the blow as much heat as could be produced by the combustion of the coal itself. But these objects move at a pace far greater than five miles a second. This earth moves at a velocity of about four times that. A number of the stars move at a far greater velocity. It is certain that those bodies in the new star had speeds which may have amounted to hundreds of miles a second. Let us suppose it to be two hundred miles a second, which is not unreasonable. A body going at five miles a second has as much energy in virtue of its motion as an equal weight of coal would yield in perfect combustion, so that if it is going at two hundred miles a second, that means it has as much energy as sixteen hundred globes of coal of the same size. Imagine two such bodies meeting in space; the energy

produced by the collision of those two bodies is equivalent to the amount of heat produced, which is sixteen hundred times as great as all the heat that could be produced by the burning of two masses of coal as big as those two bodies.

Is it any wonder, then, that by such a collision a flash can be produced that carried its message throughout the whole extent of millions and millions of miles between where we are situated and where that incident took place? Such we believe to be the origin of this star. We are not left altogether to speculation in regard to it. There are many other confirmatory circumstances. In fact, remembering the myriads of such bodies that are there it is exceedingly likely that such a collision should occur, and that it should produce such an effect as we have seen. If any one doubts that a collision can produce such a glorious radiance they have only to look at the shooting stars. A shooting star is a brilliant streak of light. In one brief fraction of a second that little object is transformed by a temperature far greater than we could produce in our most powerful furnaces into heat. It can be shown that an object a child can carry would, if it were launched as a meteor dashing into our atmosphere, produce sufficient light to astonish a large part of the earth. It has been calculated that a meteor which appeared in America some months ago and was not heavier than a pound or so, produced so much light and heat by collision with the air, that the light was as great as could be produced by an electric engine driven by a 40,000 horse-power engine, and the noise that it made was as great as if that light were accompanied by music from fog-horns, blown by another 40,000 horses.

I must add a few words as to the process of evolution, so to speak, which we see going on around us in the heavens. This subject has come very much before the attention of astronomers lately in consequence of discoveries that have recently been made. One of the greatest of philosophers, Immanuel Kant, laid the foundation of that remarkable nebular theory which ordinarily goes by the name of Laplace. Had Laplace and Sir William Herschel lived to these days, they would have heard with unbounded interest of the development of our knowledge which has arisen from photography. Here* is another point in the heavens, and here is some trace of the nebulous material—this glowing

* *Pointing to the screen.*

material which Kant imagined—for in his days they could hardly have known much of its existence.

What I want you to look at in this picture is the faint diffused light—light not from a solid material—not from the stars at a distance, but light from incandescent gas. In this picture we have instances of nebulæ which are chaotic, and here you see nebulæ in strange wisps. You might think they were little bits of cloud in the sky; but they are there, night after night, hardly to be seen with the aid of the best telescope.

There we have one of the great glories of the heavens—the great nebula in Orion, this being the famous picture taken by Dr. Isaac Roberts, and here we have parts of it above and below extending to a vast distance. [*Exhibiting on the screen.*] In this we have the nebulous gaseous material, as it were, drawing itself into shape.

Now we will look at another. This is the famous "Dumb-bell Nebula." This gives an astonishing illustration of the possibilities of the photographic plate. It has a patience and delicacy that no human eye possesses.

Now we come to another—the "Crab Nebula," as it is called. I have shown this with the view of illustrating as it were the varieties of these nebulæ. We may look at different trees in a forest—the old veteran that weathers the centuries, and then we come down gradually to the little sapling until we come to the little acorn just sprouting. We can read the history of the oak by looking at individuals in the forest. So we try to learn what nebulæ have to tell us by their structure as to the history of the individual objects.

But here is a form still more advanced. [*Exhibiting on the screen.*] Here we have a photograph of one of the most interesting subjects in the universe. That is the great spiral nebula. You can magnify it, and it will bear the test that it ought to stand. It was taken by Mr. W. E. Wilson, in Ireland—a most accomplished astronomical photographer, and I ask you to observe in this that sort of evolution that Laplace explains. Parts of it tend to form what may in all probability be the planets that are ultimately to attend on that sun in the centre. You see here indications of the direction in which the rotation proceeds. They are all moving round the same way. We see this planetary system lying near the same plane, and now there is an astonishing fact that I have to state. Here is another spiral taken by Dr. Roberts. We look at this with more interest

because in it we are looking at an object that no human eye has ever seen. The photographic plate sees it but we do not. The late Professor Keeler commenced a survey of the heavens. He took a square degree here, and one here. He took, if I may use the expression, samples of the heavens on photographic plates. On one of those plates he found three new nebulæ; on another ten; on another twenty, and on another even as many as thirty—not less than three on any one. If he were to photograph the whole heavens he would want 40,000 plates. He had only taken a dozen or so, and had not found fewer than three on any one, and ten times that number on some. If there were three new nebulæ at least on each of those 40,000 plates, that means 120,000 new nebulæ in the heavens. There is an astonishing fact to be added, and that is, of these more than one-half are spirals—hence spiral nebulæ assume great importance in the celestial economy.

Here is the last one we shall look at. It was taken by Dr. Roberts, and is generally believed to be the most remarkable astronomical photograph ever taken. It is a picture of the great nebula in Andromeda. If it could have been turned into a better position we should have found another great spiral.

These pictures show how the theory suggested by Kant and developed by Laplace is borne out in the most astonishing manner by these more recent observations with photography.

My lecture is at an end. I began with a statement of the origin, so far as we are able to discover it, of these stars which occasionally and suddenly burst into view.

I have shown how those stars arise from a collision, and I have tried to show how by a contraction of a nebula, as most of us believe, the great sun that we know in heaven came into being with its planets.

The whole tendency of modern science so far as we have been able to understand it, has been to show that what Kant and Laplace and Herschel laid down is, in the main, the actual order of events that has taken place in nature. In concluding my lecture to this Institute, where it has given me such pleasure to appear, I cannot help saying that the more we study these things, the greater is the mass of difficulties, which seem to us insuperable if we try to unravel them by the light of science alone. It is true, we believe—I myself certainly do—that our solar system has originated

from the nebula, just as I believe the adult came from the child; but if you ask me where that nebula came from?—well, we may say it came from the collision of two stars. But then comes the question, "Where did the two stars come from?" To that science really gives no answer; and as far as I can understand these things, the very circumstance of the heavens seem to me to bear written on them the impress of the fact that they cannot have gone on from all time as they are now. There must have been, so far as we can understand it, some beginning—some time at which there was an intervention of force and action such as science is not able to take cognizance of. Hence it is I cannot but express hearty sympathy with the efforts, and successful efforts, which have been made by this Institute to show that in our endeavours to understand the wonders of nature, we have ever brought before us the fact that there are innumerable mysteries in nature which can never be accounted for by the operations with which science makes us familiar, but which demands the intervention of some Higher Power than anything that man's intellect can comprehend. [Loud applause.]

The PRESIDENT.—Ladies and gentlemen, I am sure you will agree with me that we ought to pass a hearty vote of thanks to Sir Robert Ball for this most interesting and most suggestive lecture that we have just heard. Perhaps it is not quite usual to propose a vote of thanks from the chair, but in the absence of Sir Joseph Fayrer, who has been obliged to leave, and who had undertaken to move the vote of thanks, I have great pleasure in doing so. (Applause.)

I need not occupy your time—in fact, it has been so delightfully occupied during the whole of this lecture, that anything I could say now would only be coming down from a ladder. Perhaps some one here will have the goodness to second this resolution.

Dr. WALTER KIDD, F.Z.S.—I beg to second the vote of thanks to Sir Robert Ball for his valuable lecture.

[The resolution was then put and carried with acclamation.]

The SECRETARY.—I wish to be permitted to add one word to the thanks that have been accorded to my distinguished friend—a

very old friend and former colleague—Sir Robert Ball, for his kindness in coming forward on this anniversary of our Institute, at great inconvenience to himself; for to-morrow morning he is bound to start for Glasgow to attend a function in that city to which all eyes are at this present moment turned. Therefore, we thank him, not only for the fact of this most remarkable lecture, which has carried us into regions of thought and delight beyond expression, but we beg to thank him for having put himself to so much inconvenience, in order to gratify and instruct us as he has done this evening.

Sir ROBERT BALL.—I am much obliged for the very kind way in which you have received my address. When I sat down, I was only conscious of the things I ought to have said which I left unsaid.

The Rev. Canon GIRDLESTONE, M.A.—I am sure you will allow me to propose that the thanks of the meeting be presented to our President, who occupies his position, I am sure, to-night with infinite pleasure. He has never, I should say, presided at a gathering which has had more interest and satisfaction to his own mind, for we have been carried in thought into the magnitude of creation. We have been brought to a contemplation of many little specks in the universe, and of our sun, the centre of our system; but we have felt too the marvellous gift which is given to man to read the nature of the stars, thanks to the spectrum analysis, so that there has been thrown on this sheet the interpretation of this wonderful event which has been occupying our minds this evening; and as we think of the closing words of the lecturer, I cannot help rejoicing in the conviction that the Being who has scattered all these material globes through space is one we can call, "Our Father in Christ"—that we can still say in the depth of our conviction, "In the beginning it was God who created the heavens and the earth." (Applause.)

I have great pleasure in proposing that the thanks of the meeting be presented to our President.

Dr. THEOPHILUS PINCHES.—I beg to second the resolution.

[The resolution was then put and carried unanimously.]

The PRESIDENT having acknowledged the vote of thanks, the proceedings then terminated.