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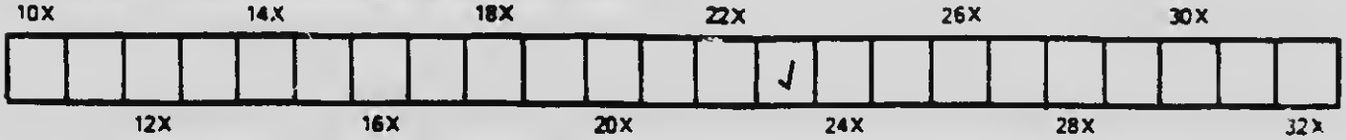

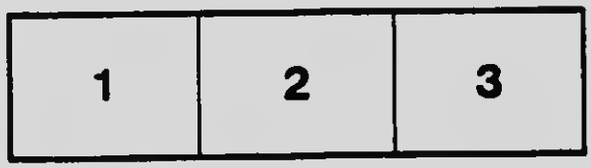

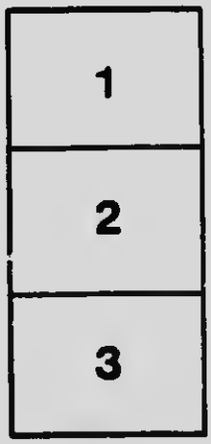

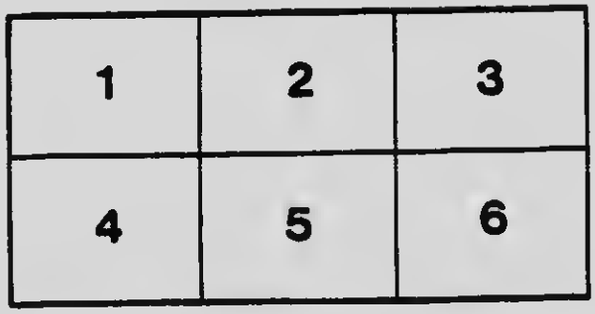

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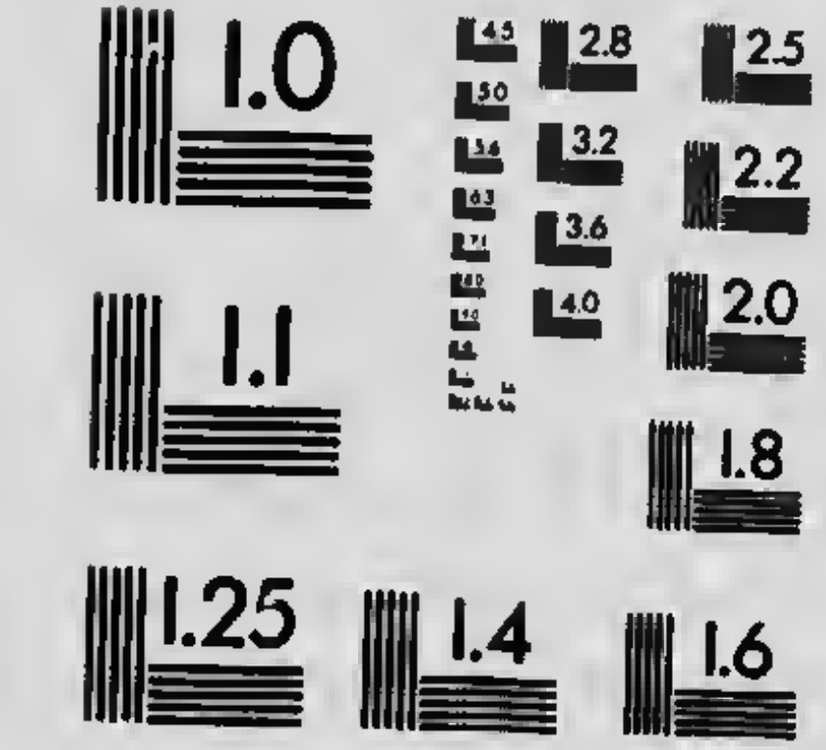

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ROYAL SOCIETY OF CANADA

FOUNDER:—HIS GRACE THE DUKE OF ARGYLL, K.T.

FIRST ANNUAL MEETING, MAY, 1882

TWENTY-FIFTH ANNUAL MEETING, MAY, 1906

ADDRESS

BY

PROF. ALEXANDER JOHNSON, M.A., LL.D., D.C.L.

PRESIDENT

(MAY 22nd, 1906)

ROYAL SOIETY OF CANADA, 1906

ADDRESS

BY

PROF. ALEXANDER JOHNSON, M.A., LL.D., D.C.L.

PRESIDENT.

Our Semi-Jubilee and Canada.

Our Semi-Jubilee has arrived, and it belongs to my office to speak of the Society, its origin, its objects, and its success.

First, however, let me express with a warm heart, although with imperfect words, the thanks which I feel that I owe to the society which has elected me to be its president at such an epoch in its history, the society which is itself representative of all that is highest and best, in the Literature and Science of the Dominion and is in sympathy with and supported by the lovers of knowledge and of intellectual culture, who have their more frequent gatherings for the same objects in the widely scattered local centres of this quarter of the empire.

How did this Society originate? Not from any action of our own. Separation by long distances and other obstacles prevented mutual acquaintance and union in the past. I speak as one who was a University Professor long before the existence of the society.

The Founder, the Duke of Argyll.

But fortunately we had in 1881, as governor-general, a far-seeing statesman, then Marquis of Lorne, who could estimate rightly the future of this country and foresee its needs. Fortunately, too, when initiating the movement, he was able to call to his assistance in organizing the young society a man so wonderfully capable and energetic as the late Sir William Dawson.

The idea was entirely that of the Marquis himself as Sir William tells us in his autobiography. Indeed Sir William says that his own preference would have been for a purely scientific society like the Royal Society of London, or the British Association, but the Marquis had

before him the thought of the French Institute also, in which literature has its place; and there is much to be said for his decision.

Literature and Science.

If I may speak as a member of our scientific division and on its behalf, we may acknowledge that while we are all proud of the wonders science has done for mankind yet if we compare its effects for good or evil with the influence of literature, we find that while the amazing productions of science may bulk large before the eye at any one place or time yet a general view brings before us the transcendent powers of literature. The costly guns and equipment of a monster man-of-war dwarf the small and inexpensive flag that floats above it. But behind the guns are only the fighting men of the ship while behind the flag are the sentiment and strength of an empire. This conviction, no doubt, prevailed with the founder of our society, although there were some practical considerations in favour of the limitation of the scheme to science, at least at the beginning.

Sir William Dawson.

Sir William accepted the views of the Marquis, and heartily co-operated in laying the foundations of a society with which, as he says himself, he hoped his name would ever be associated, as I associate it to-day. In testimony to the appreciation of his work, he was twice appointed President, a unique honour in the society

Objects of the Society.

It was intended to be the Parliament of Literature and Science for Canada, where the most eminent representatives from all the provinces could assemble for the promotion of both. It was to be a University for Universities where the teachers of teachers, and the investigators of truth, should themselves get new knowledge, while contributing the result of their researches and gaining fresh stimulus from the spirit of association. It was, in fine, to be the heart of knowledge and research, driving the life-blood through the extremities and making it circulate through the whole of the Dominion.

These were noble objects that the Duke of Argyll set before him. But more than this was evidently meant.

The Two Languages.

Such a Society would bring together the leaders of thought and culture in both languages and by mutual acquaintance tend to promote mutual respect and regard. How successful it has been in this, I suppose

we can all testify. I for one am greatly sensible how much both of benefit and pleasure I have derived from contact with the eminent men having French for their mother-tongue whom I have met here, some of whom have passed away, but whose names are not forgotten.

It was sound statesmanship, even if we look for nothing higher to create two literary sections, one for each language, as a testimony to the belief in the permanent co-existence of both languages, and so diminish and help to remove a certain nervousness on the subject which is now fading away, if not wholly departed; but which I believe would not have arisen, if many could have had the same experience as I had some years ago; to my own great astonishment, I admit.

It will be acknowledged that if the whole French-speaking population of Canada could be transferred to England and settled there within five or six hours of London, there would be much greater probability of the absorption of the French language than under present conditions. Well, you will find actually in that position, a people about the same in numbers, with a language and literature which is not English and with an enthusiasm for their language and literature which is not exceeded anywhere; who have preserved both for more than six hundred years; a people who have great weight in the Imperial Parliament, and who are more than satisfied with their influence in it and in the Empire at large. Who are more loyal to the Empire than the Welsh? I might even say, who more devoted, maintaining it with true Celtic fervour? It is their own. Nevertheless there is a large part of that people who cannot speak a word of English. Books will give you no conception of this fact. You must go and live in Wales for a short time to appreciate the reality.

I spent a month there, near the chief centre for English tourists, and yet I was sometimes obliged to use the language of signs alone to try to convey my requests; with varying results. The only part of a symbolical sentence that was an invariable success was the exhibition of the Queen's profile on silver.

Aid to the Government.

There was a hope also that the Government would sometimes find the advice of the society useful within the society's own field. That the representatives of the people at large would take counsel with the representatives of that portion of the people who live on the hill nearer the sources of knowledge from which issue the descending streams that enrich and beautify the practical life of the community. And this hope has been fulfilled.

Courtesy and Official Action of the Government.

It is an evidence of the success of our Canadian constitution that the Government elected by the people, as shown itself without distinction

of party always ready to receive the representations of this society, with courtesy, and while proceeding with deliberative caution, to act with liberality when satisfied.

Tidal and Hydrographic Surveys.

This very day one of your committees has reported two instances under two separate governments, in which surveys have been established for the safety of Canadian navigation.

Visit of the B.A.A.S. to Winnipeg.

You have also a report before you showing with what quick appreciation the present Prime Minister received a deputation from the Society last year, and how promptly, after inquiry, he agreed to propose to Parliament a handsome grant to enable us to have a visit from the British Association in Winnipeg.

International Geological Congress.

It will not be forgotten that in a previous year, a similar request concerning a visit from the International Geological Congress, was received in a similar spirit and with equal liberality. We can only regret that the Congress could not come, and hope for better fortune on a future opportunity, after the visit of the B.A.A.S. to Winnipeg, which according to precedent, may be safely counted on in due course.

Provision for Visits of Associations from other Countries.

But how are we to make sure of a future opportunity? What everybody would desire, everybody may expect his neighbour to get for him; and then every effort becomes a matter of chance; or again, two different desires may present themselves to two persons at the same time and then there may be a clash of efforts. That visits of associations like our own from other countries will be of great value to Canada and are thus very desirable, all feel; but how are we to get them if we have no system? Ought we not to put on some small committee or on the Council, the responsibility of recommending to the society from time to time, at regulated intervals, if possible, invitations for such visits?

Chance and not-chance.

If not they will be left to chance. I speak with knowledge, for if I may be excused for mentioning the fact, it was due to chance that the movements for two meetings of the B.A.A.S. in Canada (out of three

altogether), were initiated by the same individual, myself. One being for the meeting in Toronto in 1897, which was started by correspondence with leading men in Toronto immediately after my return from the Edinburgh meeting in 1892. The other for Winnipeg, as the Rev. Dr. Bryce very kindly indicated, when bringing forward the resolution last year in this society; I had been waiting for months previously to make the suggestion to him at the meeting of the society, in connection with what is now the third city in population in Canada. How ably and successfully he has organized the movement we all know. I can therefore speak with conviction when I say chance, although the chances were perhaps increased by the fact that I was connected with both the R.S.C. and the B.A.A.S. as chairman of committees of both.

What however is not a matter of chance but is due to the forethought of the Duke of Argyll, and to the corporate character of the society he founded, is, that a member who lived the retired life of a University Professor, sunk fathoms deep in lectures, as most professors were in ante-society days, and very many are now, should have had the opportunity to emerge occasionally, and through the gathering together of his colleagues from other parts of Canada and the backing and encouragement which they gave him, should have been able twice to influence the Parliament to pass such large measures for the safety of our ships on both oceans, and of the lives of our sailors; and twice to initiate the movements for bringing across the Atlantic to Canada one of the greatest scientific associations of the world.

Have we not here plain encouragement to members who from their position see, and dislike to see, Canada lagging behind on any line of national development, and are willing to undertake the laborious and often disheartening task of trying to quicken the action of the people and the government.

Central Position of Canada.

There is an additional and a strong reason for an amendment in our regulations or bye-laws so as to make specific allotment of the responsibility I advocate. It is the central position of Canada in the Empire. I have made an estimate of the time and expenses of travelling from London to Australia and New Zealand or vice versa and if any one else will do the same, he will find that they are greater than to South Africa, and so great as to preclude, in general, visits of a body of University Professors to or from those countries. But professors from Australia and New Zealand could get to Winnipeg and back in the limited time at their disposal and, no doubt, they will be invited. Besides, and this is no small advantage, the American Association can, as on former occasions, so choose its place of meeting for the year, that visits may be in-

terchanged to our mutual gain. We may hope therefore for more visits in the future than in the past and ought to make provision accordingly.

Papers in the Transactions.

So far I have spoken only of the corporate action of the society; of what it has been able to do as a body. I should have liked if it were possible, to give some sketch of an analytical classification of the mass of papers that have been published by the members during the 25 years. But who could do this with such a variety of subjects? A list of the titles; an index, would be undoubtedly of great value, and would mark the epoch in a notable manner. This, as you will see from the programme for the meeting, has been generously undertaken by the president of last year, M. B. Sulte, and for it we owe him our hearty thanks. But it must always be remembered, that the work of this society, meeting, as it does, only once a year, presents only a small part of the work done by its members. For a view of the whole we must look, not only in publishers' lists, but in the magazines and journals of this and other countries, especially for papers whose prompt publication is necessary. We made a much needed amendment, last year, in our rules so as to secure more speedy publication, which will no doubt increase in future, the number of papers in our Transactions; and to this I would call the attention of members who may not have noticed it.

It would be practical proof of the value of a society of this character to the members severally if we could conveniently collect their evidence, especially that of the senior members, who are able to contrast the past with the present; and submit even a summary. Perhaps it may be obtained in the future. Meanwhile I offer as a contribution my own experience in this and other associations, as of one fully sensible of the contrast between the ante-society days and the present time.

Principle of Verification.

In preparing this matter, the great principle of verification, of which we all know the value for the establishment of truth, whether of hypotheses, or theories, or quotations, or the meaning of words, in science or in literature, was strikingly brought before me, by instances of its neglect. Neglect too, in perhaps the least expected case, that of the labours of Newton, "qui genus humanum ingenio superavit," as the quotation from Lucretius, on his monument at Cambridge says, and the general verdict affirms.

The first two instances that I shall submit, came in my way, quite casually, at the meeting of the American Association, in Montreal, in the same year as that of the foundation of this Society.

The year after Newton's death, a work entitled the "System of the World" and professing to be by him, was published, giving in English, a kind of popular account of his discoveries. Nearly 140 years afterwards, in 1867, doubts of its genuineness were expressed in Knight's English Cyclopædia, but apparently no further inquiry was made. This book had been reprinted and bound up with an English translation of the Principia, giving the impression that it was part of the Principia. A member of the American Association, having discovered in the book a huge mathematical blunder, in calculating the attraction of two spheres, very properly reported his discovery to the mathematical and physical section, and created a very lively discussion.

By good fortune I had both books in my possession, the English "System of the World," dated 1731, and the Latin Principia in the standard edition of the present day. This proved that the former was no part of the Principia, and the enormity of the blunder settled the question about genuineness raised in the Encyclopædia. Newton could not have made it. It was of the same character as that sometimes made by a school boy at an examination, when he calculates that the interest on $300 for 6 months at 6 per cent is about $72,000.

I may add as exemplifying that science is independent of nationality, that the standard edition spoken of, was a reprint of the edition published about twelve years after Newton's death, with a commentary, also in Latin, by two Frenchmen, PP. Le Seur and Jacquier, priests of the Gallican order of Minims, that it was edited by them at Rome, and dedicated to a French Cardinal, Rohan.

The second instance occurred at the same meeting and was more interesting. For about thirty years previously English text-books on optics had been stating and even lamenting, especially after the invention of the spectroscope, that Newton had never used the slit instead of the round hole for the admission of light on the prism in the formation of the spectum. I happened to have a copy of Newton's "Opticks" and knew that the statement was wrong. He mentions very particularly the advantages of the slit. But I was afraid to write about the error. For, surely, I thought, there must be many eminent men of science in England who know of it, and if they think it unnecessary to make a correction why should I interfere? It cannot be so common as it appeared to be.

The late Dr. Rowland, of Johns Hopkins' University happened to be exhibiting his concave gratings with their beautiful effects in the resolution of the spectrum, when a prominent scientific man, after prolonged inspection, expressed the usual regret about Newton. After that I immediately wrote a short note to a weekly scientific magazine; but with

no result apparently. I subsequently repeated Newton's experiments in Newton's manner exactly, and submitted a paper thereon to this Society showing that it was absolutely impossible to avoid seeing the dark lines, although Newton makes no mention of them. In books published since that time the statement has been given correctly.

Why Newton didn't see the lines may be explained either by the fact that he trusted to an assistant of whom he speaks or that the quality of his glass was bad, possibly obstructing somewhat the passage of the light, and scattering it internally. It would appear also that for about 70 years after Newton's death nobody repeated his experiments or else the glass was bad and the lines were not discovered until Wollaston's time. His paper was published in the Philosophical Transactions in 1802.

Although quotations from the "Opticks" are not very uncommon it would appear from the next instance I shall produce that the book is difficult of access. It would be a benefit to science if some wealthy American University were to reprint so famous a work, a model of clearness and accurate experiment.

Newton and Herbert Spencer.

This third instance occurred a few years earlier, when Herbert Spencer was led to put his opinions directly in opposition to those of Newton, in Natural Philosophy itself, through a mistake about the meaning of a word in the Principia, which would have been avoided had the "Opticks" been consulted. Newton calls the laws of motion "axioms;" Spencer, evidently having in his mind the ordinary use of the word axiom in the modern editions of Euclid, as meaning a self-evident proposition, insisted that Newton employed it in this sense.

An inspiriting discussion in print followed which ended by Spencer's acknowledging that Newton attached a different meaning to the word. The proof was obtained from Newton's letters, and in the whole discussion no reference was made to the "Opticks." Yet a glance at the book would have ended the debate. Newton begins it with definitions and axioms. The "axioms" are the Laws of "Reflexion and Refraction," and these, as some school boys know, are established by experiment solely. Spencer says that Newton "gives the word axiom a sense widely unlike the sense in which it is usually accepted," implying perhaps some censure on Newton. If "usually" means usually at the present day, Spencer is correct. But is it possible he can have forgotten that a word may change its meaning with the lapse of time? A very brief inquiry would have shown that Newton used the word accurately both in the "Opticks" and the "Principia." No deeper research is required than turning over the leaves of Liddell and Scott to find that it was employed

by Aristotle to signify "that which is assumed as a basis of demonstration;" for "assumption" in short, or "postulate;" the root idea being that of worthiness, something worthy of acceptance without disputation. Nor is Euclid responsible for the word since he didn't use it, and is thus doubly free from the charge of calling his principle about parallel lines "self-evident."

The question arose in a controversy between Herbert Spencer and Prof. Tait The latter in his Thermodynamics asserts that Natural Philosophy is an experimental and not an intuitive science. "No à priori reasoning can conduct us demonstratively to a single physical truth.

"I hold, on the contrary," says Spencer "that as there are à priori mathematical truths the consciousness of which results, "not from our "individual experiences, but from the organized and inherited effects of "ancestral experiences, received throughout an immeasurable past; so "there are à priori physical truths, our consciousness of which has a like "origin. I have endeavoured to show that Prof. Tait himself by saying of physical axioms that the appropriately cultivated intelligence "sees at once their necessary truth, tacitly classes them with mathematical axioms of which this self-evidence is also the recognized character "Further I have contended that the Laws of Motion are à priori truths "of this kind; are enunciated by Newton as such"—Spencer then goes on to quote Tait's reason for asserting that the Laws of Motion are not to be accepted as valid à priori. "The reason is that as the properties of "matter might have been such as to render a totally different set of laws "axiomatic, these laws must be considered as resting on observation and "experiment, and not on intuitive perception." This is also the opinion of Newton as expressed in his letters. If Herbert Spencer had ever lectured to a class of students on the Second Law of Motion he might have been tempted to explain their want of intuitive perception of its a priori truth by a limitation of the "immeasurable past" in their "ancestral experiences," and put the origin of man as recent.

The position of Spencer in the disputation was like that of an army which while fighting the enemy in front is unexpectedly assailed in the flank by a force called in as an auxiliary. But Spencer did not quail. He faced the new foe with undaunted courage, supported probably by the conviction that while his adversary seemed to be on his own territory of Physics, he was on the very verge, if he had not actually crossed the boundary line of Metaphysics, a department which borders on all the Physical and Natural sciences, and appears to have to some students in these departments the fascinating advantage for polemic purposes of a general absence of axioms (i.e. of propositions universally admitted) Hence combatants with differing opinions can each choose his own

axioms i.e assumptions, to support his own views, and confound adversaries. Much logomachy may thus leave general satisfaction. No one is confuted.

Alchemy..

Passing on from a consideration of the uses of the Society, to recent progress in science, in which Canada like all the rest of the world, is interested; and more perhaps, than most of it, in one division of the domain of Physics, we shall come casually on other rather surprising instances of this neglect of verification. We meet also an exemplification of the epigram that it is the unexpected that happens.

Who could have expected that this advance would have brought us again to the old and apparently dead questions of alchemy? The name and the subject had been both handed over long ago to the romancists, as a legitimate province in which they might work their magic, by introducing Hermes Trismegistus, and the Philosopher's Stone, and the "Adepts;" as for example the "adept" depicted by Scott in "Kenilworth."

Sixteen centuries back, the Roman Emperor Diocletian commanded that all books on Alchemy should be burnt; but he did not thereby kill out man's greed for gain, or spirit of inquiry. Unbroken ill-success for many ages, however, produced the natural effect of despair. The historian Gibbon commenting on the fact says, "Philosophy with the aid "of experience, has at length banished the study." In this he expressed the general opinion that prevailed for more than a century.

A similar opinion was otherwise indicated by a comparatively recent writer, when, referring to the famous Friar Bacon, who lived nearly seven centuries from the present time, he said "Notwithstanding the "great learning and scientific acquirements of Bacon he was deeply im-"bued with the mystery of Alchemy: this is the more remarkable, "because he exposes the absurdity of believing in magic, necromancy or "charms." The writer classes alchemy among the "absurdities." The reputation of the celebrated friar will, however, be increased, to-day, instead of lessened by his differing opinion.

The prevailing opinion was not universal. One of the problems of the Alchemists was the transmutation of the baser metals into gold, and we know that both Boyle and Newton believed that this was attainable.

Boyle made experiments, one of which by its apparent approximation to success so alarmed Newton that he advised concealment. This may have been because of a statute of Henry IV, which forbade "the multiplying of gold and silver." Certain it is that not long before his death Boyle procured the repeal of the statute in order to remove an obstacle from the path of others. Newton himself continued his experiments to

a late period of his life. When he was a young man, about 26 years of age, he wrote to a young friend of his own, who was going to the Continent, and asked him particularly to make observations on mines and mining, and "the extracting of metals or minerals out of their ores," to learn if there were any transmutation out of one species into another, such transmutations, he adds, being "the most lucriferous and many times "lucriferous experiments, too, in philosophy."

Dr. George Wilson, brother of the late Sir Daniel Wilson, of Toronto University, in his essay on Boyle, published about the middle of the last century, remarks that there is no à priori objection to the possibility of transmutation as there is to the possibility of a self-sustaining perpetual motion. "It may be realized any day" he says.

It has been partially realized to-day, to the extent, that is, that nature has been discovered working transformations of some of the chemical elements, and science is now eagerly inquiring to how many elements the process extends. But no one has yet learned to imitate the powers of nature in this respect.

Greek Atomic Theory.

As consequences of these discoveries, two erroneous opinions have got abroad; one, of a vague popular character, that a fatal defect has been found in the basis of chemistry; the other, more definite, that the old Atomic Theory has been disestablished, and the death-knell of the Atom rung. A slight sketch may show that these opinions have no sufficient foundation.

It may occur to any one who has noticed a stone ground to powder or a drop of water subdivided to the cover of a pin-point, to inquire how far the subdivision can be carried. The question is not limited to what can be seen by the naked eye, or detected by the most powerful microscope but extends beyond the region of sight to what can be inferred by sound reasoning from careful observations.

It is, as Newton puts it, and as Lord Kelvin re-states it, not a question whether we can imagine the subdivision to go on for ever, but a practical question, whether, using the forces of Nature at our command, we come eventually to an end of subdivision, and have something indivisible, an atom. No one has ever seen an atom, and from the nature of light itself, there is no hope that we shall ever invent an instrument which will enable us to see it. Still we may safely infer the existence of atoms even though a procession of ciphers headed by unity, giving the number that would extend over the twenty-fifth part of an inch, should not help the imagination much to picture their smallness.

Sir John Herschel asserts that the idea of the atom is an absolute necessity of the "thinking mind, and is of all ages and nations."

Whewell in his "History of Scientific Ideas" says:—"The doctrine "that matter consists of minute, simple, indivisible, indestructible "particles as its ultimate elements has been current in all ages and all "countries wherever the tendency of man to wide and subtle speculation "has been active."

The progress of modern science has tended to produce a strong conviction of the truth of the theory.—The phenomena of diffusion in liquids, and gases, for example, tend to show that they not only consist of particles, but that these particles are in constant motion. As an example in solids we have that remarkable experiment of Robert-Austen, in which a cylinder of lead was placed on top of a cylinder of gold, and left for a considerable time in a warm chamber; when taken and examined gold was found diffused throughout the lead, particles of this the heavier metal having risen upwards as if they had wings.

It is certain that the theory, which long preceded the dawn of experimental science, came to modern Europe from Ancient Greece and it has been traced even to India. Strabo who lived in the reigns of the Roman emperors, Augustus and Tiberius, says that its author was Mochus or Moschus, of whom he speaks vaguely as more ancient than the Trojan war. This would make the Greek Theory not less than three thousand years old and will mark it off from Dalton's Atomic Theory which came into being only a century ago.

We have more definite statements about Democritus as author of the Atomic Theory and before him of Leucippus, although the writings of neither survive. Lucretius, the contemporary of Cicero, expounded it in his great poem "De Rerum Naturâ"—Thus it was transmitted to modern times, and became familiar. Newton gives it a compact shape. Dalton had firm faith in it.

Dalton's Atomic Theory.

From the emphasis with which Dr. George Wilson writes in his account of Dalton's "Life and Discoveries," it would almost seem as if he had foreseen the mistakes made about Dalton's Atomic Theory to-day. He says, and re-iterates, that Dalton was an Atomist before he was a Chemist—that he joined the Greek Atomic Theory, which he found in existence, with the Chemical Laws of combining proportions, but that the laws rested on a perfectly independent basis of experiment—that it was unnecessary to concede to Dalton's atoms the attribute of indivisibility, and that Dalton's contemporaries, Davy, Wollaston, Berzelius, declined to employ the word atom, because it assumed indivisibility, and that they substituted other words. In short, that the Greek Atomic Theory and the Chemical Laws are independent one of the other. That

if the link forged by Dalton between the Greek Theory and the Experimental Laws be broken, the Experimental Laws are absolutely secure while the Theory must stand or fall by its own merits.

This expresses exactly the position to-day. The link has been broken. The existence of bodies much smaller than those presented to us by Dalton as ultimate particles, as atoms, has been proved by Prof. J. J. Thomson of Cambridge; and the so-called atoms themselves are found to be complex systems masquerading as simple bodies; and are indeed gigantic impostors compared with their little successors.

Newton and Wilson.

But this does not detract from the genius and merit of Dalton, for which Wilson expresses great admiration, and is so far carried away that he does, unwittingly, a great injustice to Newton.

In contrasting the earlier views of the Atomic Theory with those of Dalton he takes Newton as representative, and quotes from the fourth edition of his "Opticks" as follows:—"All things considered" says Newton, "it seems probable that God in the beginning, formed matter in solid, "massy, hard, impenetrable, movable particles of such sizes, figures, "and with such other properties, and in such proportion to space, as "most conduced to the end for which he formed them; and that these "primitive particles, being solids, are incomparably harder than any "porous bodies compounded of them, even so very hard as never to wear "or break to pieces, no ordinary power being able to divide what God "made one in the first creation."

On this extract Wilson remarks;—

"Newton, it will be observed, says nothing concerning the weight of his primitive particles."—"It is here that Dalton introducing the "question of weight, leaves Newton behind, and takes not a step, but "a stride, in advance of all previous speculators on atomics."

Wilson has overlooked the word "massy," i.e. having mass, chosen carefully by Newton, and a very much better word in one respect than "weighty" or any other referring to weight, for if these "primitive particles" were removed to the Sun or any of the heavenly bodies or even to different parts of the Earth their weight would change, while their mass would be unchanged. Newton had proved by experiments that mass was proportional to weight (a fact ignored by many approved text-books on Mechanics in Wilson's time). That the omission by Newton of weight from the essential properties of particles was deliberate is seen by reference to the "Regulæ Philosophandi" where he states, repeats, and re-iterates the five properties, extension, hardness, impenetrability, mobility, and "vis inertiæ;" subsequently saying that he by

no means affirms ("minime affirmo") that gravity is essential to bodies, but "vis inertiæ" or "vis insita" as it is elsewhere called, is immutable. This "vis insita" he states in the Definitions is always proportional to the mass. It may also be noted that Newton does not use the word "atoms" but speaks of the smallest parts ("partes minimas"). He also employs the term undivided not indivisible—"partes indivisæ."

Wilson appears to have regarded the word "massy" in the "Optieks" as redundant, yet if it be omitted, we have only four essential properties instead of the five given in the "Principia."

Dalton's genius was as quickly recognized on the Continent as in England, perhaps even more quickly. His experience on a visit to France presents another instance of noble generosity among lovers of Science. He was so warmly welcomed by the members of the French Institute, and so much more honoured than among his own countryman that on his return home, although not given to express his feelings, he said, "If any Englishman has reason to be proud of his reception in France, I am that one."

Present View of the Atom. Transformation of Matter.

The latest advance in the study of the constitution of matter is that the Daltonian atom is of a very complex nature, a kind of infinitesimal planetary system in itself, which in the case of some, at least, of the chemical elements, seventy or so in number, is breaking up by its own internal energy, projecting streams of particles, and, after a series of steps, exhibiting a veritable transformation of one element into another. In this manner uranium is the parent of radium, and radium is the parent of helium. Further changes are the subject of eager investigation which is now in rapid and breathless progress.

Many in Canada are engaged in the research, which had its origin a few years ago in the investigations that followed the discovery of the X rays, which are now so familar to us all, and so startled us at first in exhibiting the skeleton of the hand of a living man.

Ten years ago Henri Becquerel of Paris discovered that uranium could produce in the dark, what, for want of a better word may be called photographic effects similar to those of the X-rays; the explanation being that uranium is constantly sending off invisible radiations, i.e. streams of particles, whose action is thus made visible.

P. and Mm. Curie, undertaking a patient examination of all the chemical elements in search for any with similar properties discovered radium in 1898.

The extraordinary phenomena exhibited by this and certain other elements, were linked together by the theory already given which had

its birth in Canada and has been accepted generally throughout the scientific world. Its authors were Dr. Rutherford and Mr. Soddy. Canada unfortunately has been unable to retain Mr. Soddy, but after going to England his work in the same direction bore good fruit; for he and Sir William Ramsay co-operating were able to verify a prediction of Dr. Ruthorford's. They saw the spectrum of helium grow out of the spectrum of the emanation of radium, i.e. an actual transformation of matter took place before their eyes. Dr. Rutherford had based his prediction on the fact that helium is found on the earth only in connection with elements that emit the radiations which have been here spoken of.

Other transformation have been since observed. More surprising, perhaps, because not anticipated, even in speculation, was the discovery, three years ago by M. Curie and M. Laborde, of the enormous amount of energy latent in the atom of radium and released by its disentegration; an amount sufficient to reconcile the divergent views of Physics and Geology on questions connected with the Sun's heat.

The accidental death of M. Curie a month ago in Paris must be a cause of regret to lovers of Science, while the severance of the remarkable partnership in heart and mind of those who by their scientific eminence, whether separately or in co-operation, have became familiar to all as "the two Curies" and have been known in ordinary life as M. and Mme. Curie must touch all hearts.

Comparison of Recent Advances in Physical Science.

In briefly noting the advance in one department of Physical Science since the foundation of the Society, I will take for a standard of comparison, Prof. Tait's work published in 1876 on the then "Recent Advances in Physical Science."

It had long been established, by means of the balance, that in spite of appearances, as in the case of a burning candle, it was impossible to destroy matter, just as it was impossible to create it. This principle of indestructibility is often called the "Conservation of Matter."

If we define "energy" as the capacity of doing work—such work as engineers delight in—and measure it, the companion principle of the "Conservation of Energy" asserts that it is impossible to increase or diminish the quantity of energy in the Universe. This principle was established about the middle of the last century.

But while the quantity of energy cannot be increased or diminished, the form is readily changed as when a water-fall is used to drive street-cars, or to supply electric light or heat. The Transformation of Energy was fully accepted along with its Conservation. To this there was however at the time of Tait's book no companion principle for matter,

or as Tait puts it "The laws of energy differ from those of matter in "one most important respect, so far at least as we yet know by experi- "ment. Matter cannot so far as we know be transmuted from one "kind to another, though in some cases it assumes what is called an "allotropic form. The great characteristic of energy, on the other "hand, is that, in general, we can readily transform it, (in fact it is "of use solely because it can be transformed), but in all its transfor- "mations the quantity remains precisely the same."

It will be observed that Tait is very cautious in his wording, "So far as we know," he says. His caution is justified. For here a distinct advance has been made in proving the transformation of some kinds of matter, and a vast field of inquiry has been opened.

Dissipation of Matter.

The inquiry itself suggests another companion principle whose correlation may be indicated by the term Dissipation of Matter (a term I have not yet come across), corresponding to what Lord Kelvin called the "Dissipation of Energy." This latter principle points out that "every time a transformation takes place, there is always a tendency to pass, at "least in part, from a higher or more easily transformable to a lower "or less easily transformable form.

"Thus the energy of the universe, is on the whole, constantly "passing from higher to lower forms." The low form to which it seems to tend being "that of uniformly diffused heat."

A quotation farther on, will again offer us a comparisou of "then" and "now". "Thus" he says, "so far as we can yet determine in "the far distant future of the universe' the quantities of energy will "remain absolutely as they now are." ("Then" and "Now" agree in this; they differ in the next clause viz.)—the matter unchanged alike in quantity and quality;—the energy also unchanged in quantity, but entirely transformed in quality to the low form of uniformly diffused heat.

Now the recent discoveries show that the transformations of matter which are going on in nature, are so far as observed, from "higher to lower forms" to use Tait's terms.

If then the principle, should, by a process of exhaustion, be proved to be general and the lowest form be ascertained, we shall have the companion principle and shall be able to say that in the far distant future of the universe not only will all energy be reduced to uniformly diffused heat but all matter to its lowest form.

This further permits the possibility of the supposition that some of the nebulae visible to us, instead of being the beginning of new suns or

planets, may, in fact, be the wreckage of worlds or world-systems like our own floating in the illimitable ocean of space.

When observers, then, are watching the projection of streams of particles from the matter around us, they may be really watching the wasting away of our world. This reminds me of an account I have read of a sailor in an old and leaky troop-ship on a long voyage who used to go down to the hold, and watching the tiny jets of water spurting in through the minute holes in the thin worn sides, try to estimate how long the vessel would last.

If this Trilogy of principles, Conservation, Transformation, Dissipation, should be finally established for Matter, as they have been established for Energy, the further question would arise whether, as the energy we speak of is always associated with matter, the expressions for them could not be united in one simple form.

Tait referring to the Dissipation of Energy, proceeds further to say "as it alone is able to lead us—to the necessary future of the universe "i.e. if physical laws for ever remain unchanged so it enables us dis- "tinctly to say, that the present order of things has not been evolved "through infinite past time by the agency of laws now at work, but "must have had a distinctive beginning, a state beyond which we are "utterly unable to penetrate, a state in fact that must have been pro- "duced by other than the now visibly acting Causes."

Cicero, Herschel, Clerk-Maxwell, on Atoms

This leads us to an aspect of the theory of atoms which can hardly be passed over.

Cicero in his "De Natura Deorum," Bk. I, represents Cotta, the Academic, speaking of the "absurdities in which Democritus, or before him Leucippus, used to indulge, saying that there are certain light corpuscles, some smooth, some round, some square, some crooked and bent as bows, which by a fortuitous concourse made heaven and earth, without the influence of any natural power." In the second book Balbus, the Stoic says, that he who could believe in the action of this fortuitous concourse, might believe as well that a number of metal letters could by being thrown to the ground, compose a history, e.g. the Annals of Ennius.

Sir John Herschel, in his discourse on Natural Philosophy, with the resources of modern science at his command, puts this in another light, and his argument is not affected by recent discoveries.

"The discoveries of modern chemistry," he says, "have gone far to "establish the truth of an opinion entertained by some ancients, "that the universe consists of distinct, separate, indivisible atoms or

"individual things, so minute as to escape our senses, except when "united by millions, and by this aggregation making up bodies of even "the smallest visible bulk; and we have the strongest evidence that "although there exist great and essential differences in individuals "among these atoms they may yet be arranged in a very limited number "of groups and classes, all the individuals of each of which are, to all "intents and purposes, exactly alike in all their properties.

"Now when we see a great number of things precisely alike, we do "not believe this similarity to have originated except from a common "principle independent of them, and that we recognize this likeness "chiefly by the identity of their deportment under similar circumstances "strengthens rather than weakens the conclusion.

"A line of spinning jennies, or a regiment of soldiers dressed "exactly alike, and going through precisely the same evolutions, gives us "no idea of independent existence, we must see them act out of concert, "before we can believe them to have independent wills and properties "not impressed on them from without. And this conclusion which "would be strong even were only two individuals precisely alike in all "respects, and for ever, acquires irresistible force when their number "is multiplied beyond the power of imagination to conceive. If we "mistake not, then, the discoveries alluded to, destroy the idea of an "eternal self-existent-matter, by giving to each of its atoms, the essential "characters, at once, of a manufactured article, and a subordinate agent."

It will be another illustration of Herchel's argument if we suppose that the minute-hand of every clock on a line of railway from the Atlantic to the Pacific always points to the same minute at the same moment, for then we know that there must be a controlling clock producing this effect by an electric current, and behind this controlling clock a controlling mind.

If instead of hundreds of clocks, we knew that there were countless millions of millions of clocks throughout the universe beating together, the argument would be the stronger.

Now although we have not clocks the vibration of whose pendulums are kept in unison, we have vibrating bodies in numbers transcending our power of imagination, which vibrate in exactly the same time throughout the universe. It is Clerk-Maxwell's illustration. We know by the spectroscope, that chemical elements which may be examined in this room, and which exist over all the earth, are to be found also in the Sun and in the most distant stars, stars so distant that news from them flying with the velocity of light, takes ages of ages to reach us, innumerable stars, at immeasurable distances in all directions, above, below, around us; yet in all these heavenly bodies the countless molecules of

the element hydrogen, make their quick vibrations in exactly the same period as those on earth, with a perfection of exactitude that no clock of man's construction can approach.

Haeckel.

Contrast with this, the views put forth in a book entitled: "The Riddle of the Universe," by the eminent German biologist, Professor Haeckel, a translation of which has been recently published and has, at present, a wide circulation. In it he gravely offers us, the hypothesis that every atom has in itself the rudiments of life and mind. Is this a relief to the strain of mystery? Sometimes, no doubt, obscurity is relieved by a flash of darkness, yet we are not grateful. As a comment I shall simply quote an extract from the Presidential Address of Sir George Stokes to the British Association.

Sir George Stokes.

"When from the phenomena of life we pass to those of mind, we "enter a region still more profoundly mysterious. Science can be ex- "pected to do but little to aid us here, since the instrument of research "is itself the object of investigation. It can but enlighten us as to the "depth of our ignorance and lead us to look to a higher aid for that "which most concerns our well-being."

Haeckel versus Newton.

I should hardly have alluded to Hæckel had it not been that through unpardonable want of care, he is led to make a charge against Newton which is the very reverse of the truth. His object is to disparage Newton's intellectual capacity, Newton's opinions being diametrically opposed to his own. Mere railing at an advocate is not confutation of his arguments, and is sometimes a confession of defeat. We may have here a touchstone of Hæckel's qualifications as a guide. He cannot justly complain if the same kind of test is applied to himself which he tries to apply to Newton.

If a man gives dogmatic opinions on colours, who is proved by an easy test, to be colour blind, he will not be taken as pilot for a steamship. If a diviner or seer finds himself unexpectedly put in gaol for breach of the laws, a loss of reputation for his prophecies may be expected. If a man adopts without verification an hypothesis readily proved to be false, and on that as an axiom illogically builds other hypotheses to the damage of an opponent's reputation, want of confidence in his capacity as an hypothesis-builder is *à priori* justifiable.

It is in this way that Professor Hæckel has treated Newton, whose great fame he admits. On page 217 of the recently published New York edition, he writes:—

"Newton had the immortal merit of establishing the law of gravita-
" tion and embodying it in an indisputable mathematical formula.——
" action at a distance without a medium, which Newton deduced from
" his law of gravitation, and which became one of the most serious and
" most dangerous dogmas of later physics, does not afford the slightest
" explanation of the causes of attraction; indeed it long obstructed
" our way to the real discovery of them. I cannot but suspect that his
" speculations on this mysterious action at a distance, contributed not a
" little to the leading of the great English mathematician into the ob-
" scure labyrinth of mystic dreams and theistic superstition in which he
" passed the last thirty-four years of his life."

"Mystic dreams" and "theistic superstition" is Hæckel's answer to Newton's noble hymn to the Creator at the close of the immortal "Principia."

Compare with this Newton's expression of his views in a letter to Bentley, quoted with approval by Faraday, and again, by Sir George Stokes. The fiery indignation which is felt in Newton's words, even after the lapse of two centuries would have burnt itself into the memory of any man who had taken care enough to consult Newton himself for Newton's own thoughts instead of taking, without verification, any version presented in a passing publication.

These are his words:—

"That gravity should be innate, inherent, and essential to matter
" so that one body may act on another at a distance through a vacuum
" without the mediation of anything else, by and through which their
" action and force may be conveyed from one to another, is to me so
" great an absurdity that I believe no man who has in philosophical mat-
" ters a competent faculty of thinking, can ever fall into it."

Indian Atomic Theory.

It has been asserted that the atomic theory really had its origin in India, and Democritus, who inherited great wealth from his father is said to have travelled to India, so that his views on atoms may have been modified there.

Of this Indian atomic theory Max Müller gives an account when writing of the Six Philosophical Systems of India. The distinguishing feature of one of these systems was the Atomic Theory—which maintains that there must be smallest particles admitting no further analysis—that these smallest and invisible particles are eternal in themselves, but

non-eternal as aggregates—that as aggregates again, they may be organized or inorganic. Tho atoms are supposed first to form an aggregate of two, then of three double atoms, then of four triple atoms, etc. While single atoms are indestructible, composite atoms are, by their very nature, liable to decomposition, and in that sense to destruction. The theory even made an estimate of the size of the atom, as being about one-sixth of that of the Motes that dance in a sunbeam.

This recalls an early Greek estimate of the size of the sun as being about that of tho Peloponnesus.

The Indian system of philosophy which advocates the atomic theory differs, toto cælo, from that of Democritus, expounded by Lucretius, in this respect, that it offers proofs of the existence of God, and of His omnipotence and omniscience, while the other is atheistic.

Origin of the Name of Canada.

Their direct opposition on this point has given rise in my mind to an interesting historical question, which I hope will prove interesting also to the literary division of our Society, to whom I propose to hand it over for examination, viz., was this Indian atomic theory along with the name of its author known in Europe at tho time when the first adventurers were exploring the American continent, the time of the revival of learning. If so, we may have the solution of a problem which has been the cause of much dispute, namely the origin of the name given to a small district in America, concerning which the only point of agreement is, that it is Indian.

There might be a similar question concerning Pocahontas County in Virginia, if every one did not know the love story of Pocahontes. Few would recognize the name of a philosopher, if similarily applied.

But among the scholars of those days the works of Lucretius would be well known for the beauty of his poetry, and, to use the term chosen by George Henry Lewes, tho "offeusive" character of his opinions; and correspondingly great would be their satisfaction in finding an older authority on atoms who strongly maintained the doctrino of a Supreme Intelligent Ruler of the Universe.

Now, remembering that Columbus and the early explorers, for many years after him, believed that they had actually reached India, (a name that in those days covered a large part of China as well as what we now call India): remembering also the fervid religious zeal by which many of these explorers were animated, is there anything improbable in the supposition that, hearing of this Indian philosopher, and believing they

had reached his country, they should give his name to some part of it? The name has now extended beyond the original small district, and that name is Canada.

Canada spelt with a C or a K, as in many Indian words and names, e.g., Cabul, Candahar, or English words as Kathode, Katherine, Kalendar, or America itself, which in some European languages is spelt with a K. Canada exactly as we have it on our post-cards, requiring no twisting or hacking of the stem to get the familiar form.

In submitting this hypothesis for verification I may say that I have gone no farther myself, than noting that the first Greek edition, the "*editio princeps*" of the classical work of Arrian, the Roman prefect of Cappodocia, on India, was printed in the very year in which Jacques Cartier first ascended the St. Lawrence. This may be a mere coincidence, but it seems to encourage investigation. A Latin translation had been published not long before. Every source of information about India was of course, keenly scrutinized in those days, and as Arrian was also a celebrated writer on philosophy (the Stoic philosophy) the association of ideas even if there were no other cause, would direct attention to Indian philosophy.

The suggested inquiry may be limited at first to the question whether a knowledge of the name of the Indian philosopher and of his philosophy did exist or could have existed in Europe (more especially in France), at the beginning of the 16th century.

It might be impossible to trace the course by which it travelled from India; just as we are unable to recover the history of the great debt which science owes to India in the invention of what are called the Arabic numerals, with their wonderful superiority to the Greek and Roman characters in their facilities for calculation. Yet we are sure that the knowledge percolated through from India, whether by merchants, or travellers, or writings. The shape of the figures themselves is a testimony, from the resemblance they bear to the initial letters of the corresponding Sanskrit names for the numbers.

New light will be welcomed. Only two derivations, so far as I know, have hitherto been in vogue; the first from an orginal signifying "nothing there"—which is disrespectful to the country—the other from an Indian word meaning "village," which is disrespectful to the inventive faculties of the discoverers. Neither has been accepted with favour, and both are now, in effect, buried in polite oblivion. The field is, therefore, open for fresh attempts.

Whatever be the outcome of the inquiry, it is certain that when we look on a map of the world, we find written broad across the forehead of

America, the name of an Indian philosopher, the reputed author, and undoubted teacher of the Atomic Theory, a man who in far distant and dark ages, reasoned out the belief in an Omnipotent and Ominiscient God: and held the harmony of science and religion; a position maintained to this day, by our greatest men of science, not only by Newton, but by such men as Lord Kelvin, Sir John Herschell and Sir George Stokes, Maxwell and Faraday,— the name of Canada.