THURSDAY, APRIL 13, 1876

A RESEARCH FUND FOR THE CHEMICAL SOCIETY

AN offer has lately been made to the Chemical Society, which has for its object the establishing of a fund to be applied in aiding the development of scientific chemistry. The offer comes from Dr. Longstaff, who proposes giving the society the sum of 1,000*l.*, on condition that at least an equal amount be raised and invested together with his gift, in approved security. To make this offer known to the Fellows of the Chemical Society, the following circular has been sent to them, and already the major part of the required 1,000*l.* has, in donations varying from 1*l.* to 100*l.*, been raised.

Chemical Society,
Burlington House, Piccadilly, W., March, 1876

Dear Sir,

I am instructed by the President and Council of the Chemical Society, to request your consideration of a matter, which they hope will elicit your interest and active co-operation.

The advancement of Chemical Science, which constitutes the special object of the Chemical Society, may be promoted chiefly in two ways:—

1. By facilitating the early acquirement by students of Chemistry of a knowledge of the results of chemical research carried on in this and other countries.

2. By affording direct assistance to workers in chemical science, with a view to encourage and facilitate their labours in experimental research.

The Chemical Society has sought from the time of its foundation to aid in the first of these objects by the publication of original papers communicated to the Society; and, during the last five years, a special guarantee fund and liberal aid from the British Association for the Advancement of Science have enabled the Society to establish, on a firm footing, the publication of monthly abstracts of original papers published in this country and abroad, on chemistry and allied branches of science.

The Chemical Society has also recently endeavoured, as far as its funds would permit, to afford assistance to chemists undertaking original investigations, by the extension of its library, and occasionally by grants of small sums of money, when pecuniary aid was applied for. The limited resources of the society have, however, restricted the number and amount of these grants within very narrow limits. In 1872, Mr. T. Hyde Hills placed at the disposal of the Chemical Society the sum of 10*l.* as the nucleus of a fund for promoting original research; and offered under certain conditions, made with the object of securing the co-operation of others, to contribute a like sum annually. This attempt of Mr. Hills to form a research fund was not, at the time, seconded. The Council have, however, recently received from Dr. G. D. Longstaff, one of the original members, the generous offer to place at the disposal of the society, the sum of one thousand pounds (1,000*l.*) towards establishing a permanent fund for promoting the advancement of Chemical Science, on the condition that not less than an equal amount be subscribed for the same purpose.

As the President and Council feel that such a fund would add much to the usefulness of their Society, and enable them to encourage still further the prosecution of Chemical Science, they are most desirous to secure to the Society the benefit of this munificent offer of Dr. Longstaff; and have therefore instructed me to ask your co-operation towards the attainment of this object.

I remain, Yours obediently,

WILLIAM J. RUSSELL, *Treasurer.*

Considering the use to be made of this fund, and the very large number of persons interested either in the scientific development of chemistry, or else in its many lucrative applications, it is not unreasonable to expect that a sum far larger than this 2,000*l.* will be raised.

The feeling among those most interested and most active in raising this fund, is that there should be, in the

first place, a permanent fund, the dispensers of which should have large discretionary power as to how the income is to be spent, so long as it be strictly used for the advancement of scientific chemistry, and secondly, that this fund should be aided by annual subscriptions. It is hoped that the invested capital may from time to time be largely increased by gifts; possibly as the real character and object of such a fund as this becomes better understood and more widely known, it may receive legacies and bequests such as now are devoted to charitable or religious purposes.

The direct income arising from the money which is to be invested in accordance with Dr. Longstaff's conditions cannot amount to any large sum; it is therefore hoped, and not without reason, that many will aid the fund by annual subscription, and while some may probably limit their subscriptions to a definite number of years, others may be willing to subscribe as long as they are assured that good and useful work is being done with the money thus raised.

A fund of this compound character has certain advantages; the invested capital gives permanency and keeps alive the interest in it, the subscriptions help most materially towards forming an income which will more nearly approach the requirements of the case, and there are many who would rather that what they give should be used for immediate requirements than that it should be funded for the benefit of unknown and possibly never-to-exist requirements in time to come.

One point has been urged against such a fund as this; it is that we should look rather to the State to aid research than to private generosity, and that every private fund of this kind tends to relieve the Government of some of its obligations, whereas all scientific bodies ought rather to increase such obligations, not lessen them. On the other hand the State aid, if it is to be really efficient, must be such that it will at least to some extent open out a career for those willing and able to devote themselves successfully to original investigations; while from this fund no more could be expected than that it should afford a means by which some of the best known chemists of the day, as represented by the governing body of the Chemical Society, should have within their power the means of aiding particular investigations, publishing possibly important scientific tables or other data, and making important acquisitions of books or even instruments if such be specially required by the fellows of their Society in the prosecution of scientific investigation. Undoubtedly it is beyond all question that the sphere of usefulness of the Chemical Society will be much extended by the establishment of this research fund.

W. J. RUSSELL

TAIT'S "RECENT ADVANCES IN PHYSICAL SCIENCE"

Recent Advances in Physical Science. By P. G. Tait, M.A., formerly Fellow of St. Peter's College, Cambridge, Professor of Natural Philosophy in the University of Edinburgh. (London: Macmillan and Co., 1876.)

THESE lectures, we are told in the Preface, were given in the Spring of 1874, at the desire of a number of the friends of the author—mainly professional

men—who wished to obtain in this way a notion of the chief advances made in Natural Philosophy since their student days. The demand, therefore, which these lectures are intended to meet, is that of men who, though they have received a liberal education, in which the element of science has not been neglected, are too deeply engaged in their professional work to keep themselves abreast of contemporary science by regular study, but who are yet able to avoid falling behind by occasionally availing themselves of an hour with a scientific friend.

In lectures of this kind, therefore, we are not to look for the elaborate exposition and reiterated inculcation by which the facts and methods of science are impressed upon the minds of beginners. Still less are we to expect the forcible language and striking illustrations by which those who are past hope of being even beginners may be prevented from becoming conscious of intellectual exhaustion before the hour has elapsed. We are rather to listen to one who has climbed high on the hard and slippery peaks of science as he points out the grand features of the prospect to those who stand on a lower level but yet on the same solid foundation with himself.

In his own words he has “to point out a few of the principal peaks which we have to ascend, and of the more formidable abysses which we have to avoid.”

As safety must come before success, it may be well to observe that the most formidable of all these abysses is that of *à priori* physics. The study of this branch of science as it is to be found in the works of Hegel, Herbert, and others, seems to furnish an unfailing source of recreation to those who are engaged in the less amusing researches of experimental physics. In our modern examinations those candidates who try to conceal their ignorance by sending up what appears to them to be the most plausible answer to a question, often help to relieve by their felicitous absurdities the tedious labours of the examiner. We have only to imagine that instead of the weary examiner we have the vigorous man of science, and instead of the timorous candidate, some great philosopher before whose inner vision the whole world of being and not-being, in its apparent contradiction and fundamental indifference, lies open; and we shall then have some faint idea of the mode in which the writings of these philosophers may be destined to contribute to the merriment, if not to the happiness of the coming race.

We are glad to find, however, that in spite of the contempt which Prof. Tait pours upon the *à priori* physics of non-experimental philosophers, he admits that there is a true science of metaphysics which discusses the fundamental ideas of all science and knowledge, not by shutting out all the facts of experience, but by calling in all the evidence obtainable from the whole circle of the science.

In fact one of the greatest benefits which the advance of science has conferred on the world at large is that words and phrases have been gradually introduced into ordinary language which are consistent with true scientific ideas, and that these have displaced words and phrases which implied false ideas about nature, so that each generation, as it learns its mother tongue, finds it better adapted to express what really exists, and less suggestive of what is not.

We have only to read the expositions of science in the seventeenth century to see that they are addressed to students whose minds were imbued with prejudices and superstitions which are now known only to archæologists. Those who have the good fortune to be born in these latter times can hardly realise the reasons why certain natural phenomena rather than others were dignified or stigmatised with the name of paradoxes.

The man of science, if he confines himself to writing scientific books, can influence only the professed students of science, but if he can find an audience among men of business and men of action, who desire to keep up their scientific knowledge, he will at the same time help them to keep up a scientific habit of thought and expression. In this way a course of lectures like those of Prof. Tait may do something towards infusing a scientific spirit into the affairs and phraseology of business life, and since it is of the essence of science to speak of things as they are, the business phrases which satisfy this condition will gradually but surely displace those which describe things as they are not.

The subjects discussed in these lectures are the conservation, transformation, and dissipation of energy, spectrum analysis, the conduction of heat, and the structure of matter.

The experiments by which the lectures are illustrated are many of them new, and all of them well described. We may take the following as an example of Prof. Tait's method of illustrating the connexion of radiation with absorption:—

“I can show to a few at a time, but not in a marked way at a distance, the same phenomenon [as in Stewart's experiment with pottery], by taking a piece of platinum foil and writing letters upon it with ink. When it is once heated there is a deposit, on the surface of the otherwise polished platinum foil, of oxide of iron which tarnishes the surface and makes it absorb considerably more light than a polished reflecting surface will do. We should expect, then, when this is heated (as I now heat it in a powerful but very slightly luminous flame), and becomes in turn the source of light, to see bright letters on a dark ground. The difference of brightness is not so marked in this case as in the last, but still those who are nearest to me will see the phenomenon distinctly enough.

“But you will see another phenomenon still more startling on looking at the back of the heated foil instead of the front of it. You see faint traces of bright letters on the dark ground when I turn the inked side to you, but when I turn the other side you see dark letters on a bright ground. Now, the reason why on the one side we have bright letters on a dark ground, while the other side of the same piece of metal shows dark letters on a white ground, is still more confirmatory of the result of Balfour Stewart's experiment, which I have just stated, because these letters appear dark while at present cold, because they are absorbing more than the rest of the polished surface. They appear brighter than the polished surface when heated, because they radiate more; but just because they radiate more they must become colder—must be kept permanently colder than the rest of the foil, and therefore the parts at the back of the foil, behind those which are radiating most, remain permanently colder. This is made evident when we look at the side which is without any difference of surface, as we then see, by the relative amounts of brightness, a marked distinction between the parts which are hotter and those which are colder. This is a still more complete proof of Stewart's proposition.”

We may also notice Prof. Tait's exposition of his views

with respect to the nature of comets and the origin of their light. He considers these bodies as consisting of swarms of distinct meteorites, which are illuminated partly by the light of the sun, but which also give out a light of their own arising from the numerous and violent collisions which are always taking place, especially near the nucleus where the swarm is densest. The most remarkable fact about this light is that discovered by Huggins, namely, that its spectrum is identical with that of a hydrocarbon.

We are sorry, however, not to find in this volume any exposition of that theory of Prof. Tait's concerning the development and manifestation of the tails of comets to which Sir W. Thomson referred in his presidential address to the British Association in 1871 as "Tait's beautiful sea-bird analogy." A "tactic arrangement" of brickbats extending over millions of miles would perhaps account for what at present appears from a dynamical point of view most paradoxical in the behaviour of comets' tails, but the dynamical explanation of this tactic arrangement itself seems still to remain as a desideratum of the theory.

J. CLERK MAXWELL

DR. BALL ON SCREWS

The Theory of Screws; a Study in the Dynamics of a Rigid Body. By R. S. Ball, LL.D., F.R.S., Andrews' Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. (Dublin: Hodges, Foster, and Co., 1876.)

DR. BALL has published several papers of late years on the subject here treated. The present volume contains the substance of these papers re-cast, with additional matter, and with a greatly improved terminology.

It has been shown by the combined labours of Poinso, Chasles, and Möbius, that there is a perfect mathematical identity between the composition of forces and couples on the one hand, and of rotations and translations on the other. Every small movement of a rigid body consists of rotation round a definite line combined with sliding along it, in other words, consists of a *twist* on a definite screw, and every system of forces applied to a rigid body is reducible to a force along a definite line, together with a couple round it. The force is the analogue of the rotation, the couple is the analogue of the translation, and the combined action of the force and couple is called by Dr. Ball a *wrench* on a screw. In each case the screw consists of the definite line (fixed in position but unlimited in length), associated with a definite length, called the *pitch*, namely, the quotient of the translation by the rotation, or of the couple by the force. The *amplitude* of a twist is the magnitude of the rotation; the *intensity* of a wrench is the magnitude of the force. A twist, or its analogue a wrench, is defined by six numbers, one of which may be the amplitude or intensity, and the other five will then be common to all twists and wrenches on the same screw. A screw is therefore defined by five numbers.

When a body twists while acted on by a wrench, the work done by the latter is the continued product of the amplitude of the twist, the intensity of the wrench, and a third factor called the *virtual co-efficient* of the two screws. The virtual co-efficient is a symmetrical function of the two screws, and when it vanishes the two screws are called *reciprocal*. In other words two screws

are said to be reciprocal if a wrench on one of them does no work in virtue of a twist on the other.

Taking six screws at random in space, we can express any twist as the resultant of six twists, one on each of these screws, and the amplitudes of the six components are called the *screw co-ordinates* of the resultant. Wrenches can be expressed in the same way, *intensity* being substituted for *amplitude*.

If we take five screws and combine arbitrary twists upon them, we obtain an infinite number of resultant twists on an infinite number of resultant screws. These resultant screws constitute a *screw-complex* of the 5th order; and in like manner we may have complexes of lower orders down to the 2nd.

Given a complex of the 5th order, one definite screw can be found which is reciprocal to it, that is to say, which is reciprocal to every screw contained in the complex. One practical application of this theorem is, that if a rigid body has freedom of the 5th order (or one degree of constraint), one definite screw can be found such that a wrench upon it can do no work on the body. Given any complex of the n th order, there is one definite complex of the $6 - n$ th order that is reciprocal to it, in the sense that every screw of the one complex is reciprocal to every screw of the other.

In general problems on the dynamics of a rigid body, it is usually advantageous to select the six screws of reference, so that each of them shall be reciprocal to the other five. Such screws are called *co-reciprocals*.

For example, in discussing the action of wrenches on a body which has freedom of the 4th order (two degrees of constraint), four of the co-reciprocals should be selected from the complex which defines the freedom, and the other two will then of necessity define that other complex of the 2nd order which is reciprocal to it and includes every wrench that can be exerted by the constraints. When an applied wrench is resolved into its components on these six co-reciprocals, the first four components determine the movement of the body, the other two being completely destroyed by the reaction of the constraints.

It is not to be imagined that a wrench applied to a free body tends in general to make it twist on the same screw on which the wrench lies. If, however, we take six screws coinciding two and two with the principal axes at the centre of mass, and having pitches $\pm a$, $\pm b$, $\pm c$, where a , b , c denote the radii of gyration round these axes, these six screws will possess the property in question—an impulsive wrench on any one of them produces an instantaneous twist on the same. Dr. Ball calls these the six *principal screws of inertia* for a free body, and he further shows that a constrained body has a smaller number of such screws, the defect from six being equal to the number of degrees of constraint.

Again, he shows that if a body has freedom of the n th order, and has a position of stable equilibrium under the action of forces which have a potential, n screws (called *harmonic screws*) can be found possessing the following property, viz., that the body can execute small oscillations on any one of them, and will execute such oscillations if it receive an arbitrary displacement and initial twist-velocity upon it. Also that any possible small oscillations of the body can be resolved into n independent oscillations on the harmonic screws.