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A POSSIBLE WINDFALL FOR SCIENCE

IN a recent article we referred to the question of the amalgamation, so to speak, of the astronomical and civil day, in connection with the introduction of world time or prime meridian time, suggested by the Washington Conference. We pointed out that there were various opinions touching the time at which the change should be made, but that the concensus in its favour is so strong that it is certain to be made some time or another.

Our contemporary *Science* has recently called attention to a point which, if carried out, will make the work complete at an annual saving on the outlay of the present of something like 20,000*l.*

How is this to come about? In this wise. Let us suppose four nations *A*, *B*, *C*, or *D*, who each support a national observatory chiefly for the benefit of its Marine. This benefit consists in telling the mariners at what instant, according to the time shown by the clocks of *A*, *B*, *C*, or *D*, any celestial event, useful to him for determining his place at sea, will happen.

Let four ships, one of them representing each one nation, be within a cable's length of each other in the middle of the Pacific when the time comes for making an observation to determine position. Four books will be used, the production of which has been enormously costly, as each consists almost entirely of figures which depend upon elaborate calculations.

If the books are rightly calculated and the captains are skilful, of course the same position will come out in each case.

Evidently this work has been done four times over, and it is equally obvious that the result should have come out the same if the position had been determined properly on either ship from data supplied by either book. Why is this? Because our nations, though they have accepted in common the art of printing, the art of binding of printed pages together to form a book, and Arabic numerals, have not accepted a common time.

To come down from our generalities the four ships might have belonged to Germany, France, the United States, and Great Britain, and the four books might have been the *Berliner Jahrbuch*, the *Connaissance des Temps*, the *American Ephemeris*, and the *Nautical Almanac*. Sympathetically with these four books, at least three different times might have been indicated by the chronometers. And here lies the point. *Because* these chronometers show the time at Paris, or Berlin, or London therefore the computations of each celestial event, using the same data, employing the same processes, have been undertaken by each nation.

But even this is not all. We have said that at least three different times might have been indicated, and on our supposition only three times would have been indicated, because the U.S. Marine actually use Greenwich time.

Now it is clear that the general introduction of world time or prime meridian time, with the idea of which we are beginning to be familiar, will do for time what the introduction of the Arabic numeral did for numbers—it will denationalise and generalise it whenever necessary; and each observatory, sooner or later, is certain to have a clock showing the prime meridian time of the earth as it has one already of the skies, and when this comes about it will be to the general advantage for all to deal with the common time for purposes common to the planet.

Now among these what can be imagined more planetary than those with which the mariner has to do, and if this be so why shall there not be one unique planetary ephemeris.

From the abstract point of view more than one ephemeris cannot be defended, though it may be pardoned if, as *Science* suggests, the nations, to save their *amour propre*, must have ephemerides for their several meridians "much the same as all patent medicine firms and pill vendors feel the need of an almanac and calendar for the conservation of individual interests: it saves themselves and their patrons the indignity of referring to somebody else's almanac, and advertises the fact that they are enterprising enough to have one."

We cannot believe that the feeling characterised above, though it exists, would stand in the way of such a vast saving of labour and such a general improvement as might be brought about by an International Ephemeris, provided the question were well ventilated and wisely discussed by a congress summoned *ad hoc*. On this point *Science* writes:—

"It is certain that the deliberations of such a congress could not fail to advise governmental co-operation in the preparation of the nautical almanacs now existing, national pride aside, and this might be done in a multitude of ways, most prominently in the case of the preparation of the data relating to the moon. Take, for example, the hourly lunar ephemeris and the lunar distances as printed each year in the *British Nautical Almanac* and the *American Ephemeris*. These data occupy about one-third of the entire number of pages of each of these publications; they are now prepared independently by the two offices, but are, when printed, substantially identical in both; and, further, the work being done at about the same time in the two countries, the results of the one do not serve any sufficient purpose as a check upon the accuracy of the other. The cost of this part of the almanac alone to each nation amounts to several thousand dollars annually,—an amount which might be reduced one-half by the preparation of these data conjointly, to say nothing of other immediate and favourable results which might be secured by such co-operation.

"The wisest conservatism would appear to suggest the annual publication by the nations conjointly of a single volume of astronomical predictions, which, in addition to other improvements, should combine all those desirable features not dependent upon individual meridians, and which in some degree characterise all the astronomical ephemerides of the several Governments. The contents and arrangement of the articles of such an ephemeris could only be determined by an international conference. While this may be little better than mere speculation, any one who has the four principal ephemerides in constant use will readily recognise how small a portion of each is employed, and, with extended interpolation-tables, how little the inconvenience of using the ideal ephemeris solely would be."

It is sufficiently obvious that this enormous simplification and improvement must come about some time or the other, and it is to be hoped that no very long time will be allowed to elapse before some Government

stirs in the matter. We have already a permanent international organisation, which, if its functions were to be extended so as to include the measurement of time as well as of space, might consider the question without any large increase of its numbers ; we refer to the *Commission du Mètre*, which already largely consists of astronomers. We point this out to show that there are no real difficulties in the way of a preliminary consideration of the matter—nay more, that there are ways of reducing the difficulties by the choice of a body which already exists, and exists too in France, where the idea of a neutral meridian still lingers. We believe that a serious practical discussion would show that the idea which lies at the root of the contention for a neutral meridian is as impossible now as it has been in the past with regard to other international-isations, such as Roman letters and Arabic numerals. If this were so, a great step would have been gained.

The writer in *Science*, however, does not propose that the Governments should be urged forward by any idea of saving their share of the sum we have already mentioned, and quite rightly. The idea is thrown out that it should be spent in an international mountain observatory, where in turns astronomers of all countries could carry out their special researches. The idea is a most admirable one, and will commend itself to all who know how years, and we may even say centuries, are being lost by heart-breaking attempts to do at a low level important work which is really only practicable at a high elevation.

PROFESSOR TAIT'S "PROPERTIES OF MATTER"

Properties of Matter. By Prof. Tait. (Edinburgh: Black, 1885.)

THE subject of this excellent little book includes the mechanical properties of matter, and much that is usually treated under the head of Chemical Physics, such as Diffusion and Capillarity. It might be difficult to give a reason why the electric and thermal conductivities of mercury, for example, should not be included among its properties as much as its density and its capillarity ; but the distinction is convenient, and to some extent sanctioned by usage.

In the introductory chapters the author expounds some rather peculiar views with perhaps more insistance than is desirable in an elementary work. The word "force" is introduced apologetically, and with the explanation that "as it does not denote either matter or energy it is not a term for anything objective." No one will dispute the immense importance of the property of conservation, but the author appears to me to press his view too far. As Dr. Lodge has already pointed out, if conservation is to be the test of existence, Prof. Tait himself does not exist. I forbear from speculating what Dr. Lodge will say when he reads on p. 11 that "not to have its price is conclusive against objectivity."

Chapters IV. to VII. form an elementary treatise on Mechanics, in which even the learned reader will find much that is interesting in the way of acute remark and illustration. Under the head of Gravitation are considered Kepler's laws, the experimental methods for determining the constant of gravitation ("the mean density of the earth"), and the attempts (such as Le Sage's) which have been made to explain the origin of gravitation.

The succeeding chapters on the deformation of solids and the compression of solids, liquids, and gases, are perhaps the most valuable part of the work, and will convey a much needed precision of ideas to many students of physics whose want of mathematical training deters them from consulting the rather formidable writings of the original workers in this field. The connection of Young's modulus of elasticity, applicable to a rod subject to purely longitudinal pull or push, with the more fundamental elastic constants expressing the behaviour of the body under hydrostatic pressure and pure shearing stress respectively, is demonstrated in full. Prof. Tait remarks that "Young's treatment of the subject of elasticity is one of the few really imperfect portions of his great work ('Lectures on Natural Philosophy.'). He gives the value of his modulus for water, mercury, air, &c. !" A deficiency of explanation must be admitted, but I am not sure that Young's ideas were really confused. The modulus for solids corresponds to a condition of no lateral *force*, that for liquids to no lateral *extension*. The distinction should certainly have been pointed out ; but the moduli are really comparable in respect of very important effects, which Young probably had in his mind—viz. the propagation of sound along a bar of the solid in one case, and in the other through a fluid, whether unlimited or contained in an unyielding tube.

As a great admirer of Dr. Young's work, I cannot resist adding that if in some respects his treatment of elasticity is defective, in others it is in advance of many modern writings. Witness the following passage :—"There is, however, a limit beyond which the velocity of a body striking another cannot be increased without overcoming its resilience, and breaking it, however small the bulk of the first body may be, and this limit depends upon the inertia of the parts of the second body, which must not be disregarded, when they are impelled with a considerable velocity. For it is demonstrable that there is a certain velocity, dependent on the nature of a substance, with which the effect of any impulse or pressure is transmitted through it ; a certain portion of time, which is shorter, according as the body is more elastic, being required for the propagation of the force through any part of it ; and if the actual velocity of any impulse be in a greater proportion to the velocity than the extension or compression, of which the substance is capable, is to its whole length, it is obvious that a separation must be produced, since no parts can be extended or compressed which are not yet affected by the impulse, and the length of the portion affected at any instant is not sufficient to allow the required extension or compression."

The theory of "bending" and of "torsion" are discussed in Chapter XI. When the section of the rod deviates from the circular form, the torsional problem becomes rather complicated ; but a statement is given of some of the interesting results of Saint Venant's investigations. In his treatment of the compression of solids and liquids, the author is able to make valuable contributions derived from his own experimental work.

In the chapter on "gases," a long extract is given from Boyle's "Defence of the Doctrine Touching the Spring and Weight of the Air," in order to show how completely