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FRAGMENTS.

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I.

THOSE who read my articles[1] upon the Electron, Atom and Molecule, and upon Phantom Matter will understand readily this fragmentary contribution. Some fifty years ago, there was advanced a very important chemical theory known as the Periodic Law. Its main point was, "if all known elements are arranged in order of their atomic weights it is found that certain chemical properties recur at definite intervals." The scale on which the atomic weights are measured is such that the weight of hydrogen is taken as unity, but in practice, for technical reasons, it is more usual to take that of oxygen or 16, which is almost exactly the same thing. For the lower atomic weights the cycle goes with a gap of 8 between each element of a group. Thus boron and aluminium are both in the third group and numbered 5 and 13 respectively, similarly nitrogen and phosphorus in the fifth group are 7 and 15. But after two complete cycles the gap changes to 18 as instanced by strontium and barium, both in the second group, but numbered 38 and 56 respectively. Originally, the periodic table was very imperfect, and in consequence was open to much criticism, but the researches of recent years have filled in many vacant places, with the result that the periodic law holds now an important place in both physics and chemistry as bearing on the theory of the fundamental nature of matter.

It is well known that the resemblances of corresponding elements are sometimes not very marked, but they are sufficiently so to prove that

[1] Published in this Journal, June and December, 1914.

there must be some underlying principle, and this has enabled chemists to predict the existence of elements through the presence of a missing space in the table. To the physicist we owe the filling in of these vacant spaces. A commencement was made by the discovery of the rare gases of the atmosphere or a group of elements which are entirely inert and entering into no chemical combination. After a while, they were placed finally into a zero group of the periodic table. In this position, the six gases, helium, neon, argon, krypton, xenon and radium emanation constitute a missing link between the strongly electro-negative halogens and the strongly electro-positive alkali-metals, as their electro potential is both plus and minus. By this means a continuous line or series of the elements was formed when they were arranged according to increasing atomic weight. Then came the development of the electrical theory of matter, and Thomson's work which showed that all atoms contain a common constituent called the electron or a particle with a perfectly definite and constant charge of negative electricity, and having a mass of about one eighteen-hundredth of a hydrogen atom. By examining the dispersal or scattering of an X-ray beam when traversing matter, it was found possible to count the number of electrons scattered under definite conditions, with the result that it was found that the number of electrons in an atom was practically the same as half the value of the atomic weight itself. Subsequent work on the radio-active substances confirmed this conclusion. Radio-activity is the succession of transformations of a substance through a definite series of states, each state having all the properties associated with the term "element." In the act of transformation each atom throws off a high-speed particle, the particle being characteristic of the element which is changing. There are two different kinds of particle thrown off, known as α and β particles. The α particle is really a helium atom carrying a positive electric charge equal to twice that of an electron; the β particle is an electron. Both particles travel at high velocities and have high penetrative powers, but the α particle is the more massive and the more penetrating.

These discoveries led to the formation of the theory of atomic structure which holds that an atom has a nucleus of very small dimensions carrying practically the whole of its mass and loaded with a charge of positive electricity equal to some multiple of the charge of an electron. This charge is neutralized by a group of electrons around it, and the number of elementary charges of electricity in the nucleus is the fundamental character which determines the chemical nature of the atom. Chemical processes, therefore, resolve themselves into the scraping off or detachment of one or more electrons from an atom. This work on the radio-active substances led further to the conclusion that the number of elementary charges of positive electricity concentrated on the nucleus of the atom gave the atomic number of a given element in the periodic table, and that

TABLE I.—THE TABLE OF ELEMENTS.

1	Hydrogen ..	1·008	32	Germanium ..	72·5	63	Europium ..	152·0
2	Helium ..	3·99	33	Arsenic	75·0	64	Gadolinium ..	157·0
3	Lithium ..	6·94	34	Selenium ..	79·0	65	Terbium ..	159·0
4	Beryllium ..	9·1	35	Bromine ..	79·9	66	Dysprosium ..	162·0
5	Boron	11·0	36	Krypton ..	82·9	67	Holmium ..	
6	Carbon ..	12·0	37	Rubidium ..	85·0	68	Erbium ..	167·0
7	Nitrogen ..	14·0	38	Strontium ..	87·0	69	Thulium ..	168·5
8	Oxygen ..	16·0	39	Yttrium ..	88·7	70	Ytterbium ..	173·5
9	Fluorine ..	19·0	40	Zirconium ..	90·6	71	Lutecium ..	175·0
10	Neon	20·2	41	Niobium ..	93·5	72	Keltium ..	?
11	Sodium ..	23·0	42	Molybdenum ..	96·0	73	Tantalum ..	181·5
12	Magnesium ..	24·3	43	?		74	Tungsten ..	184·0
13	Aluminium ..	27·1	44	Ruthenium ..	101·0	75	?	
14	Silicon	28·3	45	Rhodium ..	102·0	76	Osmium ..	191·0
15	Phosphorus ..	31·0	46	Palladium ..	106·7	77	Iridium ..	193·0
16	Sulphur ..	32·0	47	Silver	107·9	78	Platinum ..	195·0
17	Chlorine ..	35·46	48	Cadmium ..	112·0	79	Gold	197·2
18	Argon	39·8	49	Indium	115·0	80	Mercury ..	200·6
19	Potassium ..	39·9	50	Tin	118·7	81	Thallium ..	204·0
20	Calcium ..	40·1	51	Antimony ..	120·0	82	Lead	207·2
21	Scandium ..	44·0	52	Tellurium ..	126·9	83	Bismuth ..	208·0
22	Titanium ..	48·0	53	Iodine	127·5	84	Polonium ..	?
23	Vanadium ..	51·0	54	Xenon	130·0	85	?	
24	Chromium ..	52·0	55	Cæsium ..	133·0	86	Radium emanations ?	
25	Manganese ..	55·0	56	Barium ..	137·0	87	?	
26	Iron	56·0	57	Lanthanum ..	139·0	88	Radium ..	226·0
27	Cobalt ..	58·7	58	Cerium	140·0	89	Actinium ..	?
28	Nickel ..	59·9	59	Praseodymium	141·0	90	Thorium ..	232·1
29	Copper	63·6	60	Neodymium ..	144·0	91	Brevium ..	?
30	Zinc	65·4	61	?		92	Uranium ..	238·2
31	Gallium ..	70·0	62	Samarium ..	150·0			

this number was practically half the atomic weight or a little less. In this manner it has been determined that the periodic table provides for ninety-two elements from hydrogen the lightest to uranium the heaviest, and moreover, that under present terrestrial conditions elements of a higher atomic weight than uranium cannot exist. The radio-active elements, therefore, indicate the upper limit of a periodic system. The next question was how many of the gaps remained to be discovered. This problem was solved by Moseley's work at Oxford upon the high-frequency spectra whereby he filled in all but three of the vacant spaces between aluminium, which is No. 13, to gold, which is No. 79, discovered a number of rare earths, and established their places as elements in the periodic table. The present position is that there are only five missing numbers, namely, those of atomic numbers 43, 61, 75, 85, and 87. The first three come between aluminium and gold; of these the first two are somewhat like manganese and would have atomic weights about 100 and 190, while the third is a rare earth with an atomic weight about 148. The remaining two are in the radio-active region, probably 85, being a halogen and 87 an alkali-metal.

In Table I the reader will find a complete list of the elements as now known. The figures in the upper line are the atomic numbers expressing the element's place in the periodic table, while the figures after each element are the atomic weights, both being in terms of hydrogen as unity. Radium, when discovered, fell naturally into the then vacant space No. 88, and the three radio-active emanations or products of radium, actinium, and thorium respectively, occupy the place No. 86. The space No. 91 is known to be occupied by a product of uranium, called brevium, because it has a period of average life of only $1\frac{2}{3}$ minutes. Thus radio-activity and the researches arising out of it has filled all but two of the last places of the periodic table and has even done more. It has crowded into ten of these places, that is between 81 and 92, no less than 39 other distinct elements. These do not appear in the list as there is no place for them, but, as elements occupying any one place they are called *isotopes*. These isotopes have different radio-active behaviours but the same chemical characters, and as such are quite inseparable by any chemical means. Ionium is isotopic with thorium, also mesothorium I with radium, and so on. To the spectroscopist and chemist they would be taken as one, but not so, however, to the newer methods of the physicist.

Reverting to the α and β particles, it is noteworthy that the expulsion of these particles from an atom leaves a new atom with properties different from the parent, but different in a very definite way. If it is the α particle which is expelled, the element after this expulsion changes its whole chemical character and passes from the place it occupies in the periodic table to a new place, next but one to it in the direction of diminishing atomic weight. If the expelled particle is a β particle, the change of place is invariably into the next place in the opposite direction. After three changes in any order, one α and two β expulsions which is a very common sequence in the radio-active series, the element returns to the place it first occupied. Its atomic weight, however, will be and is less than it was by four units, but in its whole chemical nature and its spectrum it is not merely like its original parent, it is chemically identical with it. Those elements which so occupy the same group in the periodic table, and are absolutely identical in all their chemical properties, are the so-called isotopes. The periodic table is given in Table II, with the ninety-two elements arranged in their various groups. The places in the periodic table represent integral net charges of electricity in the constitution of the nucleus of the atom. Nature does not deal in fractions of an atom of electricity any more than with fractions of an atom of matter. As we pass from hydrogen to uranium, we pass ninety-two places in the periodic table, each element differing from the one preceding it by a unit charge or "atom" of positive electricity in its nucleus. Hydrogen has one such, and uranium ninety-two such unit positive charges.

If the weights of all the particles it emits during transformation are subtracted from the weight of a uranium atom, the result should give the weight of the end-product. It happens that there is a loss of eight α particles and some β particles. The weight of these latter is insignificant and can be ignored. Since the weight of each α particle is 4, the loss is 32, and the atomic weight of the end-product is therefore 238·2 less 32, or 206·2. If the same be done in respect of the sequence of changes of thorium, according to the α and β change rule, the atomic weight should be 208. In both cases the final product occupies place No. 82 which is occupied by lead, and the end-product is lead. Now the atomic weight of common lead is 207·2, and this suggests that common lead is a mixture of isotopes rather than a single homogeneous element. This is the accepted view, and the atomic weight of lead varies with the source. True, the difference is small but, roughly speaking, lead from thorium is $\frac{1}{4}$ per cent heavier than common lead, while lead from uranium is some $\frac{1}{2}$ per cent lighter than common lead. If such a difference occurred with gold, then the banker would be liable to be out by 1 to 2 sovereigns in every 400, if he relied upon weighing the coins only instead of counting them as well.

Having mentioned the golden sovereign, a coin we have not seen for some time, it is pertinent to ask whether these new discoveries advance us toward the goal of alchemy, and how to make gold from lead or mercury. If we look at the periodic table, we see that gold is followed by mercury thallium, lead and bismuth. To get gold, all we have to do is to expel one beta particle from the atom of mercury which will give us thallium, then to expel one alpha particle from the thallium atom which will turn the thallium into gold. Or, if we wish to get gold from lead, then we must expel one alpha particle from the lead atom which will turn it into mercury and proceed as before. This is very easy to write, but the

TABLE II.—THE PERIODIC TABLE.

0	I	II	III	IV	V	VI	VII	VIII
							Hydrogen	
Helium	Lithium	Beryllium	Boron	Carbon	Nitrogen	Oxygen	Fluorine	
Neon	Sodium	Magnesium	Aluminium	Silicon	Phosphorus	Sulphur	Chlorine	
Argon	Potassium	Calcium	Scandium	Titanium	Vanadium	Chromium	Manganese	Iron. Cobalt. Nickel
	Copper	Zinc	Gallium	Germanium	Arsenic	Selenium	Bromine	
Krypton	Rubidium	Strontium	Yttrium	Zirconium	Niobium	Molybdenum	43	Ruthenium. Rhodium. Palladium
	Silver	Cadmium	Indium	Tin	Antimony	Tellurium	Iodine	
Xenon	Cæsium	Barium	Lanthanum	Cerium	Praseodymium	Neodymium	61	
	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	
	Thulium	Ytterbium	Lutecium	Keltium	Tantalum	Tungsten	75	Osmium. Iridium. Platinum
	Gold	Mercury	Thallium	Lead	Bismuth	Polonium	85	
Radium emanation	87	Radium	Actinium	Thorium	Brevium	Uranium		

difficulty exists that no one knows how to expel either an alpha or a beta particle from an atom when they want to. Nature alone knows the method, and if she wishes to apply it man cannot prevent her. But suppose we did know how to do all this, would it be worth our while? I think not, because the energy liberated and available would exceed in value and importance the gold. Possibly it would pay rather to transmute gold into some baser metal, and once we knew how to handle all the energy involved in these transmutations, war would not be the drawn-out agony as known in our time, but the destruction of a group of enemy countries secured with a swiftness that would leave nothing more to be desired.

So much for the newer conception of the elements and their sub-atomic structure; it is worth thinking further of the distribution of these chemical elements. Some interesting work in this connexion has been done by Clarke.[1] He has estimated the distribution of the elements in the lithosphere or solid crust of the earth, in the hydrosphere or oceans and lakes, and in the atmosphere or gaseous envelope. If expressed as mere percentages the figures he gives are not very illuminating, but a new interpretation of them has been given by Hackh[2] who, by dividing Clarke's figures by the atomic weight of the individual element, arrives at the proportion of atoms concerned. Taking the most abundant twenty-five elements, he finds that the relative proportion of atoms was lowest for bromine, namely, 0·000125, and using this as unity the relative abundance of atoms of any given element is obtained by dividing the relative proportion of the atoms by 0·000125. These new values are given as follows:—

O	249,850	Mg	6,855	Ti	714	N	171	V	23
H	75,312	Ca	6,422	Cl	451	Mn	116	Li	22
Si	72,860	Fe	5,982	Fl	421	Ba	46	Sr	16
Al	21,528	K	4,660	P	283	Cr	46	Zr	13
Na	8,200	C	1,199	S	274	Ni	26	Br	1

The simple meaning of these figures is that for each bromine atom in the lithosphere there are some 250,000 oxygen atoms and 75,000 hydrogen atoms, while for each carbon atom there are about 250 oxygen atoms and seventy-five hydrogen atoms. It is significant that all the important elements have a low atomic weight. Furthermore, with the exception of titanium, the same elements all enter into life or the biosphere. Another point is that all the important and preponderating elements occupy neighbouring positions in the periodic system, while the few which are of high atomic weight are near the group of noble inert gases. It is curious to find

[1] Clarke: *United States Geographical Survey Bulletin*, C 16.

[2] Hackh: *Journ. of Gen. Phys.*, 1919, p. 429; also *Science*, 1919, p. 328; and *Journ. Amer. Chem. Soc.*, 1918, p. 1023.

that only hydrogen, oxygen, nitrogen and carbon are to be found in all the four spheres, that is, in the lithosphere, the hydrosphere, the atmosphere, and the biosphere. These elements constitute nearly ninety-nine per cent of all living matter; on the other hand, the quartette sodium, magnesium, aluminium, and silicon with their oxides form the basis of all rocks and are predominant in the lithosphere. Associated with, and next in frequency to, the foregoing eight elements are six others—namely, iron, lime, potassium, chlorine, phosphorus, and sulphur. These fourteen elements not only make the bulk of known matter, but also are the essential elements of every material science. It may be unwise to draw any conclusion from the facts, but it seems highly suggestive of a material evolution in the universe. Our earth is an integral although an insignificant part of the cosmos and as such must share in cosmic evolution. Can we say that the excess or abundance of certain elements on this earth is the index of a stage or state of evolution? We know that in celestial or stellar bodies there are indications of a stellar evolution going on; why should not the abundance of terrestrial elements indicate the earth's stage of evolution? We have no guarantee or evidence that the chemical and physical characteristics of what we call sodium or potassium to-day were the same millions of years ago when the earth was younger, or that they will be the same in the ages to come. The life on this earth is based practically on carbon. Are we to assume that it is the only possible one in the universe, and that a life based on silicon, aluminium or sodium cannot exist? Few will be inclined to affirm it, and so the riddle remains.

II.

The intellectual world has been perturbed by a so-called new theory of relativity. It is not easy to understand, and is very difficult to explain without reference to mathematics. I am not competent so to explain the theory but, in its broadest aspects, relativity is based on the assumption that all measurements and observations reveal only relations between the observer and the object observed. In the domain of physics it is based on the complete absence of experimental evidence that any optical, dynamical, or electro-magnetic effects arise from the motion of matter relative to the æther or space in the absolute sense of the word. It is a common conception that the earth, sun, and stars are floating, completely immersed in a sea of space; and the modern theory of relativity says that we neither know, nor can ever know, how great or how small may be the velocity with which the earth or the stars move in that space. Velocity has to be expressed in some such units as miles per hour, and the miles covered by the moving body in a unit of time have to be measured from some definite point in space. But space is featureless; hence, velocity in space is meaningless until some points in space have been named which may be regarded either as fixed or as moving in some definite way relatively to space. Hitherto velocity in space has been measured relatively to the so-called fixed stars, but these same stars are only fixed because they are so far away from the earth that we cannot detect any change in our distance from them.

But to featureless space, commonly called the æther, has been attributed the property of transmitting light at a definite velocity, and it is remarkable that the velocity of light is the same for all directions of travel. It is difficult to reconcile this latter fact to the idea of an æther as we have conceived the æther to be. It is tantamount to saying that a man can swim up stream with the same velocity as he can swim across it, which is contrary to all experience. If the earth is moving through the light-conveying æther and the velocity of light relatively to this æther is fixed and always the same no matter what the direction may be, then the only explanation possible is that the eventually perpendicular paths along which light travels in equal times are not in truth equal paths. That is, the up-stream path through the æther must actually be shorter than the cross-stream path. The amount of any contraction, if it actually occur, can never be detected or measured because both the measure and the thing measured suffer the same contraction. Conceivably, therefore, our velocity through space may be so great that a yard-measure lying north and south may contract to any length when laid east and west.

Explanations of most scientific phenomena are sought in terms of the motion of particles of matter. The complete history of the motion of a particle in space can be recorded by stating its exact distance from, say, the floor, one end wall and one side wall of a room at a sufficient number of moments of time. In such a case three intersecting lines representing respectively the length (x), the height (y), and the breadth (z) of the room will be called the frame of reference in relation to which the position of the particle is defined. These axes, x, y and z, are mutually perpendicular and make possible the exact definition of the position of the particle in three-dimensional space within the frame of reference of the walls of the room. If against each of the points representing the consecutive positions of the particle in space we imagine the time at which the particle occupies this position to be written, we obtain a complete record of the motion of the particle in space and time. In order to simplify the recording of the consecutive positions in time, it is usual to speak of a fourth axis t, supposed to be perpendicular to x, to y, and to z, along which the position of the particle in time may be measured. It often happens that observations are being made upon an object by several different observers with reference to whom and their respective frames the object has different relative velocities. Now intelligible comparison between the observations made by the various observers can be made only if the differences in their velocities relatively to the observed system can be properly allowed for. Let us imagine that two observers S and S′ are observing the same object from different positions. The new theory is an attempt to explain the connexion between the spatial and temporal measurements of the observers in the system S and S′.

Leaving out the mathematics, if the S observers measure the time of an event idealized by them as instantaneous to be t units of time after a chosen original instant, and the place of its occurrence, which is idealized as a point, to have co-ordinates x, y and z, relative to their fixed frame of axes, then the S′ observers will record their observations of the same event with time and space co-ordinates t', x', y', z', the same being fixed relative to them. Mathematically, the equations connecting these eight quantities are a set of four linear equations. Certain consequences follow from the solution of these equations; they are (1) The dimensions of a body are not the same to observers for whom it is fixed as to observers for whom it is in motion; that is, bodies or objects are shorter to observers past whom they are moving in a direction parallel to the motion. (2) If two events occur at a locality, the time interval between them is not the same to the observers S and S′; that is, all periodic mechanisms appear to go slower to observers in relative motion to them than to observers at rest relative to them. (3) A group of observers regard an event which occurs at one place as simultaneous with another event which occurs at another place, these events will not be regarded as simultaneous by any other group of observers who are in relative motion to the first group. There is nothing in this to contradict any impressions made in the mind of a single observer as to the time relations to him of two events that come under his own direct observation.

To the astronomer and physicist, these newer conceptions of the law of relativity are of the first importance as they transform the mathematical equations for some complex physical phenomenon when expressed in terms of measurements made in one frame of reference to a simpler mathematical form when expressed in terms of measurements made in another frame. The point to be specially observed is this, that since, according to the theory of relativity, we never can measure velocity relative to the æther, we must allow ourselves to assume that any desired frame of reference, arbitrarily chosen for convenience, is at rest in the cosmos or in an æther, and thus calculate the velocity of some other frame of reference relatively to the one we have fixed. The transformation obtained then involves only the relative velocity of the frames. It is for this reason that the theory is called "relativity." A simple illustration will give some idea of the bearing of the newer conception on the problem of phenomena in the neighbourhood of a single gravitating centre. Observers moving in any path under the action of the centre would observe that the paths of all bodies in their immediate neighbourhood would for the time being be straight, because both observers and bodies would be experiencing the same acceleration towards the centre with reference to axes whose origin is at the centre. Obviously, more distant bodies would not be moving in straight paths relative to the observers because the accelerations are different in different parts of the field, and the bodies adjacent at the moment would in time separate from the observers and consequently lose the property of rectilinear motion relative to them. For proximate bodies, the frame of reference natural to the observers is one in which motion is the simplest possible, that is uniform, and the frame is equivalent to one in which force is absent, and the gravitation of the centre is transformed away by choosing axes of length and time. By this a simple equation for an element of an orbit is obtained. By replacing our measures of time and length by those made by an observer fixed at the centre and to whom we are in relative motion, and by using the relativity equations which hold at the moment, we arrive at the equation of the orbital element for this observer. On the principle of equivalence, it is postulated that to moving observers a ray of light *in vacuo* has also the simplest path in their vicinity, that is straight, and, by the same laws of relativity or transformation, it is curved in any fixed frame of reference, a result confirmed by the recent Eclipse expedition.

In plain language, the velocity of light in a gravitational field would not be constant, and consequently a ray of light passing through a gravitional field of varying intensity is refracted just as light is refracted through a lens on account of the difference of the velocities of light in air and glass. In its practical application, the new theory demands that mathematical devices be used whereby a straight line is imagined to be bent and a plane surface curved. The new theory explains gravitation in terms of motion of the frame of reference, and can be illustrated by the example of a lift. If that lift be falling freely, the frame of reference would be the framework of the lift, and those in the lift would be in a space freed from gravitational action or rather gravitation would be represented by an acceleration of the frame of reference. For accuracy, the lift must be conceived to be of very small area, in which all the lines of gravitational force are parallel. On a flat earth, gravity might be explained away in terms of acceleration of the frame of reference, and consequently be said not to exist. But our earth is not flat, therefore mathematical devices have to be introduced to explain gravity. In the case of our hypothetical lift, if a ball be thrown horizontally across that lift when it is at rest, the path of the ball will be a parabola, but when the lift is falling freely and the frame of reference accelerated, then the path of the ball thrown horizontally across it would be a straight line. Thus, a straight line becomes a parabola when a gravitational field is introduced and the gravitational field is said to distort space and introduce error into the Euclidian geometry of our youth. I ask pardon from the reader, for I fear that these explanations do confuse rather than explain. Anyhow, it seems probable that the theory of relativity has come to stay, though its effect upon either the theory or practice of medicine is remote. At present there stand to its credit a correct quantitative explanation of the variation of the mass of an electron with its velocity, the satisfactory reconciliation of optical experiments in aberration, and the prediction of the refraction or bending of a ray of light in a gravitational field.

As regards the effect of the new theory of relativity upon Newtonian transformations, it may be said that the legitimacy and accuracy of the Newtonian principles are obvious and, for all ordinary problems, their practical application can be made in a way which shows precise agreement between all observers. But in some unusual cases, such as those of electrons in which relative velocities approaching the velocity of light have to be observed, application of the Newtonian transformation has led to discordant results. The theory of relativity has been able to explain these discordant results by showing, not that the Newtonian principle is wrong, but that it is inapplicable to the results of practical measurements because the quantities we measure are apparent distances and times, and the Newtonian transformation is applicable, of course, only to true distances and true times. When explained in terms of the æther, the theory of relativity says that no experiment ever can detect motion relatively to the æther, and consistently with this, it says that every observer carrying with him a source of light will, as a matter of convention, assign to light the same velocity relatively to the source and also to the æther that every other observer, moving or not, assigns to it. However, the theory of relativity is not dependent on the existence or the non-existence of one unique æther, and if the latest facts as to the bending of a stream of light and its uniform velocity in all directions seem inconsistent with the conception of a unique æther, it is quite permissible for us to elaborate the æther idea by supposing every source of light to have its own æther fixed relatively to it.

III.

If the reader has struggled through the foregoing attempt to explain a fragment of the newer knowledge he will, doubtless, be convinced that there is a new theory of the universe and, if he be without mathematical aptitude, is possibly racking his brains to form some visual picture of the new cosmic regime. In case he does not discover it for himself, I suggest that he look at the world and society around him, and that to become initiated in the newer knowledge all he has to do is to abandon the habit of visualizing. Perhaps he is too old or too lazy to give up old habits and take on new ones; or, may be like myself, he is making heroic efforts and just as he sees victory within grasp, he finds himself tripped up by the old atavism and left reflecting intently upon nothingness.

Together, he and I can resolve to behave like men of the world; and even if we are unable to understand the new world, the new people, and the new ways, we can at least be cynical and cover our cynicism with the plausible pretence of having some respect for cosmic decencies. The gist of the theory of relativity seems to be that space creates its own times and distances, and also its own matter. What are we to do? We, who stand for law and order, fortified with a Greenwich meridian and a Greenwich mean time! Truly, the world is topsy-turvy, and the outlook is bad if the universe is to be run by millions of Soviets each creating its own space and time, and with each of which we must readjust our frames of reference. On the other hand, from chance scraps of knowledge or information as to normal velocities prevalent in space and feasible to calculate for those who can establish relativity with the occupants of space, the prospect opens up some possibilities especially by way of making excursions. For instance, are we not within hope of being able to make a circular tour with the velocity of light to regions little dreamed of under our former philosophy, and, moreover, be able to return therefrom but a few minutes older than when we started? On such an expedition there will be no need for worries as to exceeding the speed limit, for the law of Nature forbids it. In some distant star, and after having established a new frame of reference, we shall be able to pass a little time in observing what is going on and probably be able to crowd into a few seconds some experiences which take many years of our time. Of course, with such superlative excitements there may be superlative dangers, not the least being perhaps an inability to come back, or even to return to one's home only to find that every other living thing on the earth had disappeared as the effect of a new glacial epoch. Possibly the new universe without shams and pretences is more adapted to life without pretences than our old regime. Life on this mundane sphere is just now rather overloaded with pretences. We set our watches by Big Ben and pretend that it is five when we know that it is only four o'clock. By so doing we catch our trains and get home in time for dinner, but the material clock that chimes and strikes the hours awakes no echoes within us. The time we really care about and the timepiece by which we set our lives is a far more individual affair.

I know a man of so optimistic a temperament that he maintains that the secret of life is the power to see that one's local time is everything, and that of Greenwich to be negligible. To him, local time is nothing but the relation between events of importance, and by these latter he makes his co-ordinates both as to time and space. To my friend and to many others, life consists not in a sequence of events unrolled through the years, but in the sudden upward leaps of the individual human spirit. It is all a question of sine and co-sine, of plane and angle whereby an unexpected side glance at life may, and often does reveal a new unity. If this be true of life here, why should it be otherwise with the universe? The man who sleeps under a hay-rick may be a good-for-nothing, but he gets a better sight of the stars than the man who sleeps under a roof, and so it may be with the author of the new theory of relativity. He has seen a way by which reality could be taken in flank, and has not hesitated to question what was thought to be an unquestionable thing. This is a trait of all those who have seemed to steer that frail bark called humanity. The humanity that sets its watch by the Big Bens or by the local station clock is slow to obey the helm. The people who live by their own or individual time are often dull and impractical or even unconventional but test them by what they achieve and comprehend, and they will be found to make those who adjust themselves by the station clock or by the Big Bens to look absurd. The lesson is, that Relativity, like Charity, begins at home, and that the timepiece within us is the safer guide by which to plan our hours and days.

IV.

Listening to the talk of some young men in a train, a few days ago, I could not help recalling Johnson's opinion that "words mean what they mean and no other sort of thing," and wondering to myself whether language, with other arts, is not going astray towards the meaningless owing to the modern passion for novelty. We are familiar with a school of painters who, seeking to achieve something new, take refuge in distortion and the misuse of colour. In the hands of a genius, the endeavour is interesting but with the mediocre it becomes but a fashion being, in aspiration, on a level with a woman's delight in some novel contortion of dress. There seems to be a tendency in these days, not less demoralizing than the tricks of decadent painters, to make use of outrageous verbal expressions. These really are misapplied words and not new epithets born of new circumstances. There is no such fact as an old beauty or an old truth because those things are always of to-day. The modern misapplication of words involves an irreparable loss because the beauty and grace of words which have served as a real purpose in our language are undergoing a disfigurement which may cause our losing the very meaning of what are really valuable assets.

If so, then those who love our language or appreciate its beauty and strength should insist that the misapplication of words, however cunning in its wit or in its apparent fitness, is a cankerous growth which withers where it attacks. Words that mean what they mean remain in a vocabulary through the ages and make explicit for generation after generation the significance of things valuable to the heart of man. On the other hand, the construction or dressings of language, the pronunciation, the colloquial idiom and the meaning of terms not of fundamental importance, change and are evanescent. Language may change or be enriched by new words but the isolated words of primal significance remain meaning what they mean and no other sort of thing. Who can deny that words in themselves are beautifully comprehensive? The phrase may cheat but never the word. Nothing that we can add to the utterance of the old Saxon word "God" can enrich the real significance of its meaning, but much can belittle it. Who can find better synonyms for such words as land, home, mother, child, love, hate, joy, evil, flower or ship? These are all words that call for no sentence to accompany or explain their meaning.

It is well known that both in ordinary conversation and in literature special words take to themselves a sudden importance in the mouths and fingers of individuals. I am conscious that I myself have a tendency to use certain words which dominate without producing actually a sense of repetition. I have noticed the same in others, and it would almost seem as if certain words insist upon coming back to us and the mind plays upon their extension into phrase and their reabsorption. Possibly, it is all the result of subconsciousness, but it does not invalidate the argument as to a real danger to our language by the thoughtless misuse of words at the present time. I plead for the view that the infinite meaning of one word does bring to us the delight of language, and that the properly applied word gives an inspired message, an explanation, an emphasized assertion and a detailed description which is both poetry and prose, enabling us to live more intimately with the significance of the symbol which that word is. We are all proud to have inherited and let us be anxious to enrich, to keep pure rather than to impair, the instrument which served a Shakespeare, a Milton, a Bunyan and a Wordsworth. Every language has its anomalies but every language has likewise its improprieties. The line between an anomaly and an impropriety is not perhaps easy to draw, but let us be mindful of their existence, be heedful of the warning and be encouraged to persevere in withstanding their baleful influence upon the language which should be our pride. Too frequently, the world is satisfied with words; few care to dive beneath the surface. As Isaiah said, "Woe to them that call evil good and good evil."