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Iterative Hierarchical Mechanics

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ITERATIVE HIERARCHICAL MECHANICS

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SUMMARY

By viewing the velocity of a compound system hierarchically the concept of mass can be replaced by the concept of internal velocity at both the engineering and the subnuclear scale.

At the engineering level, this change in viewpoint leads to a much clearer understanding of the tautologous nature of the momentum and energy conservation laws. At the subnuclear level it also leads to a more intelligible explanation of the effect of velocity on the change in the rate of decay of subnuclear particles and suggests that nuclear reactors could be subjected to unforeseen hazards resulting from an inadequate conceptual basis for the fundamental decay equation.

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ITERATIVE HIERARCHICAL MECHANICS

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Introduction

Research into the properties of materials with special reference to concrete has revealed certain deficiencies in the conceptual structure of the present mechanical theory employed in the analysis of material behaviour[1-5].

Traditional physical concepts are strongly connected for phenomena within a given order of element size but very weakly connected for phenomena having different orders of size. Consequently the conceptual structure resembles a multi-storey building with very open floor areas connected by very narrow stairways in which there is considerable communication within floors but very much less between floors.

There are some notable exceptions to this general rule, the use of mathematics as a tool and the notion of energy as a concept, being the most obvious. Also, as the different sciences have grown independently, their isolation has been reduced by the development of interdisciplinary sciences such as physical chemistry, biochemistry, materials science, etc. which take concepts developed in one discipline and seek to utilize them in a different discipline higher or lower in order element size. Material science, for example, uses information gained at the structural micro- scale of materials to improve knowledge of the behaviour at the macro- scale of engineering structures. Conversely, the kinetic theory of gases uses the Newtonian laws of mechanics obtained at the macro-scale to understand the behaviour of matter in motion on the micro-scale.

Unfortunately, such examples are rather isolated, especially when dealing with sciences which are conceptually far apart. The relation between force and acceleration has no bearing on the science of psychology and to compare the flow of electric field between a proton "heart" source and its accompanying electron "cell" sink with the circulation of the blood would be considered fanciful to say the least, the concept of virtual photon exchange notwithstanding.

The problem of unifying the conceptual language of science is similar to the problem of unifying the everyday language of different countries. Because of historically poor communications national groups developed in considerable isolation from each other and evolution of their languages reached a point where normal communication across national boundaries became impossible.

The writer believes he now understands the problem of vertical structuring well enough to begin construction of a hierarchical mechanics which like the Analysis of Variance, partitions observed physical differences into nested compartments which have identical structures when looked at from the appropriate levels. The constant conceptual datum shift required to cope with such a mechanics may be compared with following the value of a constantly changing variable through an programming loop but the insights provided by such datum shifts are well worth the intellectual effort.

This note gives a simple example of the power of hierarchical structuring. It is demonstrated that at the two extremes of mechanical phenomena, the engineering and the sub-nuclear scale, the concept of mass is redundant and may be replaced by the concept of internal velocity with a considerable simplification of the conceptual structure required for understanding.

The bootstrap principle

The method of analysis used in this note essentially relies on what may best be described as the bootstrap principle. The application of this method is based on the acute insights into the nature of scientific research arrived at by a mathematician, the late Professor J.L.Synge and made public in the series of Statutory Public Lectures of the School of Theoretical Physics, Dublin Institute of Advanced Studies delivered in Trinity College Dublin, 1949[6].

Synge showed that definitions of the qualitative concepts of physics are inevitably circular. This idea is most readily illustrated by considering the definition of words using a dictionary. Ultimately the definitions must be circular since words can only be defined in terms of other words.

If the vicious circles of definition are large there is a natural but unfortunate tendency to loose sight of the fact that a chain of definitions must close upon itself. In terms of the dictionary this danger can be avoided by setting up small vicious circles of definitions such as, To exist is to occur

To occur is to exist

In order to understand material phenomena properly, it is necessary to limit concepts in the same way so as to provide a small closed system with no loose conceptual ends. This closed system philosophy is the basis of the arguments put forward in this note.

However, as mathematicians found out[7,8], 2000 years after Euclid, any logical system cannot be completely closed. In mathematics, the starting point "must be a set of undefined elements and relations and a set of unprovable propositions involving them and from these all other propositions are to be derived by the methods of formal logic"[9]. For mechanics the starting point is the material universe and the unprovable propositions are the methods of observation.

The main difficulty that the contents of this note will pose for the reader is a psychological one. The mathematics involved could hardly be more elementary and though the concepts require the exercise of a little imagination their grasp is well within the capacity of any intelligent schoolboy. Indeed a schoolboy might do rather better than the average graduate since the valleys cut into his mind by streams of education are relatively shallow and it is easier for him to ascend to the virgin plateau where he has an unconstrained view.

The problem is that once a scientific phenomena has been completely comprehended its "scientific" content seems to evaporate. Science essentially involves a translation process, translating the natural language of scientific phenomena which we have not learnt and cannot understand into a conceptual and mathematical language which we have learnt and can understand.

If we learn to speak the natural language like a native then we no longer need the translator anymore than we need a translation process when we learn to speak and think in French. We no longer ask, like the little boy, "Mummy, why does that funny man call our door a porte", because we see things face to face as nature sees them and the translation process is redundant (see also APPENDIX I).

Engineering scale analysis of the nature of mass

In this analysis the symbols used and the layout of the equations is based on that given by Jeans in his Introduction to the Kinetic Theory of Gases[10]. Though the mathematics only involves simple algebra and as such is accessible to all readers familiar with A level dynamics, the constant change in signs can be confusing and so a simple numerical example is given along with the algebraic equations.

Consider the impact of two elastic bodies m′ and m (2 and 5 kg) The gross velocities before impact are μ' and μ (9 and 3 m/s) The gross velocities after impact are $\bar{\mu}'$ and $\bar{\mu}$. The reason for describing these as gross velocities will be explained later.

The x direction, i.e. movement to the right of the page, will be taken as positive velocity and the -x direction as negative velocity. The component of velocity in the y direction will be assumed constant and is irrelevant to the analysis.

(a) Hierarchical conservation of momentum equation

For an elastic collision momentum and kinetic energy are conserved, hence

momentum before impact = momentum after impact

$$m'\mu' + m\,\mu = m'\bar{\mu}' + m\,\bar{\mu} \qquad \text{..........(1)}$$

$$2 \times 9 + 5 \times 3 = m'\bar{\mu}' + m\,\bar{\mu} \qquad \text{.........(1a)}$$

$$\bar{\mu} = 6.6 - 0.4\bar{\mu}' \qquad \text{.......(1b)}$$

and

K.E. before impact = K.E. after impact

$$\tfrac{1}{2}\, m'\mu'^2 + \tfrac{1}{2}\, m\,\mu^2 = \tfrac{1}{2}\, m'\bar{\mu}'^2 + \tfrac{1}{2}\, m\,\bar{\mu}^2 \qquad \text{.......(2)}$$

$$0.5 \times 2 \times 81 + 0.5 \times 5 \times 9 = \bar{\mu}'^2 + 2.5\,\bar{\mu}'^2 \qquad \text{......(2a)}$$

Substituting for $\bar{\mu}$ from 1(b) in 2(a) gives:

$$1.4\,\bar{\mu}'^2 - 13.2\,\bar{\mu}' + 5.4 = 0 \qquad \text{......(2b)}$$

and solving equation (2b) gives:

$$\bar{\mu}' = +0.4286 \qquad \text{......(2c)}$$

whence,

$$\bar{\mu} = +6.4286 \qquad \text{......(2e)}$$

Looked at hierarchically, velocity may be viewed as existing at two levels, a high order velocity V averaged over equal intervals of time before and after impact and defined by the equation:

$$V = \tfrac{1}{2}(\mu' + \bar{\mu}') = \tfrac{1}{2}(\mu + \bar{\mu}) \qquad \text{.......(3)}$$

$$4.7143 = \tfrac{1}{2}(9 + 0.4286) = \tfrac{1}{2}(3 + 6.4286) \qquad \text{......(3a)}$$

and low order velocities obtained by subtracting the high order velocity, V, from the gross velocities, μ', μ, $\bar{\mu}'$ and $\bar{\mu}$.

In symbols:

$$\nu' = \mu' - V \qquad \text{................(4)}$$
$$\nu = \mu - V \qquad \text{................(5)}$$
$$\bar{\nu}' = \bar{\mu}' - V \qquad \text{................(6)}$$
$$\bar{\nu} = \bar{\mu} - V \qquad \text{................(7)}$$

and from equation (3)

$$\nu' = -\bar{\nu}' \qquad \text{................(8)}$$
$$\bar{\nu} = -\nu \qquad \text{................(9)}$$

The μ velocities can now be seen as the sum of the low order, 'within batch' velocities ν', ν, $\bar{\nu}'$, $\bar{\nu}$ and the high order, 'between batch' velocity V. Substituting the numerical values gives:

$$\nu' = +9 - 4.7143 = +4.2857 \qquad \text{...........(4a)}$$
$$\nu = +3 - 4.7143 = -1.7143 \qquad \text{...........(5a)}$$
$$\bar{\nu}' = +0.4286 - 4.7143 = -4.2857 \qquad \text{...........(6a)}$$
$$\bar{\nu} = +6.4286 - 4.7143 = +1.7143 \qquad \text{...........(7a)}$$

From equations (4) to (9):

$$\mu'/v' \; + \; \mu/(-v) \; = \; \bar{\mu}'/(-\bar{v}') \; + \; \bar{\mu}/\bar{v} \qquad \text{......(10)}$$

Substituting from equations (8) and (9) and rearranging

$$(1/v')\,\mu' \; + \; (1/\bar{v})\,\mu \; = \; (1/v')\bar{\mu}' \; + \; (1/\bar{v})\bar{\mu} \qquad \text{....(11)}$$

Equation (11) is isomorphic to the conservation of momentum equation (1). The masses m' and m have been replaced by the reciprocal internal velocities $(1/v')$ and $(1/\bar{v})$. Numerically the individual terms in equation (11) differ from the individual terms in equation (1) because there is only an arbitrary connection between kilograms and feet per second whereas there is a necessary connection between the v and μ values since both are velocities.

The conversion factor between mass and internal velocity for elastic impacts in which no energy is passed up or down the hierarchical levels is,

$$\text{C.F.} \; = \; \frac{\dfrac{1}{\bar{v}} + \dfrac{1}{v'}}{\text{M}} \qquad \text{......(12)}$$

and for the example given, C.F. = 0.1166

(b) Hierarchical conservation of energy equation

From equation (11)

$$(1/\bar{v})(\bar{\mu} - \mu) \; = \; -(1/v')(\bar{\mu}' - \mu') \qquad \text{......(13)}$$

and from equation (3)

$$\tfrac{1}{2}(\bar{\mu} + \mu) \; = \; \tfrac{1}{2}(\bar{\mu}' + \mu') \qquad \text{......(14)}$$

From (13) and (14) by multiplication of corresponding sides:

$$\tfrac{1}{2}(1/\bar{v})(\bar{\mu}^2 - \mu^2) \; = \; -\tfrac{1}{2}(1/v')(\bar{\mu}'^2 - \mu'^2) \qquad \text{......(15)}$$

or by slight transposition:

$$\tfrac{1}{2}(1/v')\mu'^2 + \tfrac{1}{2}(1/\bar{v})\mu^2 \quad = \quad \tfrac{1}{2}(1/v')\bar{\mu}'^2 + \tfrac{1}{2}(1/\bar{v})\bar{\mu}^2 \qquad \text{......(16)}$$

Equation (16) is isomorphic to the conservation of energy equation (2). The masses m' and m have been replaced by the reciprocal internal velocities $(1/v')$ and $(1/\bar{v})$. The mass to internal velocity conversion factor, equation (12), is the same for the conservation of energy as for the conservation of momentum, equation (11).

However, there is an important difference between the hierarchical forms of the two conservation laws. Whereas the momentum equation is dimensionless, the energy equation is not. This hierarchical hiatus between the traditional anthropocentric concepts of energy and momentum has important physical implications but it is not appropriate to elucidate these in this note.

(c) Comparison of conventional and hierarchical views

In the conventional calculation of the final velocities (equations 1 and 2), use was made of the mass values of 2 kg and 5 kg. In fact, only the ratio of masses is necessary for the calculation because in both the conservation of energy and the conservation of momentum equations, m' and m are arranged symmetrically on both sides so the equations can simply divided through by m' or m.

Hence, only 3 independent values are needed to make the system determinate. If, as in the conventional calculation, the mass ratio and the initial velocity are explicitly known, the final velocity can be calculated from the equations:

$$\left.\begin{aligned} \bar{\mu}' &= \frac{[2\mu - \mu'(1 - m'/m)]}{[1 + m'/m]} \\ \bar{\mu} &= \frac{[2\mu' + \mu(m/m' - 1)]}{[1 + m/m']} \end{aligned}\right\} \qquad \text{.............(17)}$$

which can be derived from combining the conservation of energy with the conservation of momentum equations (equations (1) and (2)).

Alternatively, given the following 3 independent values

High level velocity of total substance,	V
Low level velocity of first part,	ν'
Low level velocity of remaining part,	ν

then

$$\left.\begin{array}{lll} \mu' & = & V + \nu' \\ \bar{\mu}' & = & V - \bar{\nu}' \\ \mu & = & V - \nu \\ \bar{\mu} & = & V + \bar{\nu} \end{array}\right\} \quad \text{............ (18)}$$

Comparing the complexity of equations (17) with the simplicity of equations (18), it is clear that the latter is the more direct way of viewing the system. Indeed, because the latter method is so simple it may be argued that the initial and final velocities of the parts are hidden inside the values given and hence no calculation is necessary. It may further be argued that, in contrast, the final velocity values are unknown at the start of the former conventional method of calculation and it is only by waiting for the passage of time, during which interaction takes place within the constraints of the conservation of momentum and energy, that the final velocities can be determined.

And yet, for both methods, no more and no less than 3 independent values are needed to make the system determinate. It logically follows that the final velocities must be hidden in the values of mass ratio and initial velocity. In combination with the initial velocities, the mass ratio determines the final velocities. Conversely, if the mass ratio wasn't known, it could be calculated from carrying out the interaction and determining the final velocities. Hence stating the mass ratio is an alternative way of stating the outcome. It is therefore a delusion because it suggests that the outcome is unknown, when in reality in order to know the mass ratio the interaction or its equivalent must have already been carried out. Or as Synge warns us, "Gentlemen, you are chasing your own tails" (see APPENDIX I).

(d) Hierarchical similitude between conservation equations

Viewed from a moving datum the conservation of energy can be seen as the continuance of internal velocity.

Just as the momentum conservation equation expresses the high level constancy of the system, i.e. the mass M (= m1 + m2) continues at uniform velocity unaffected by internal elastic collisions, so also the energy conservation equation reflects a low level constancy that is also unaffected by the internal elastic collision.

The high level constancy of velocity is easily recognized because using the concepts of traditional dynamics the two masses can be mentally replaced by a single mass at the centre of gravity. Recognition of the low level constancy requires much greater mental effort because it is difficult to think of the tiny amount of energy that passes from one body to another at impact as material since velocity is not normally thought of in substantial terms, though in view of the convertibility of mass and energy, it should be.

The problem is that the amount of positive (or negative) substance transferred is so minute in relation to the total amount of substance that it cannot be measured in ordinary experiments. Also, the transferred substance goes from a body having one value of mass, m1 or m2, to a body having a totally different value of mass, m2 or m1, and so the effect of the transferred substance is different in velocity terms. This contrasts with the behaviour at a higher level, the momentum conservation level, where the mass, M, associated with the forward velocity before the point of internal collision is exactly the same as the mass, M, associated with the forward velocity after the point of internal collision.

The transfer of substance can be understood in two object related ways. (a) The velocity substance can be likened to a flying spot on a monitor screen which refreshes an area , A, on the left side of the screen each unit of time, tA. This unit of time is the basic cycle time, the tick of the clock for that area A; tA's second say, not of course equal to our second. Movement of area A to the right is accomplished by gaining a new pixel on the right hand side of area A and and losing a pixel on the left hand side.

A similar spot moves another area, B, equal to 2A, towards the left side of the screen. Since B is twice the area of A it takes B's spot twice as long in terms of our anthropocentric time to refresh the area B as A's spot takes to

An alternative way of understanding the hierarchical exchange is to view the objective time as reversing at the point of impact. In this case the reverse motion of A is not a different motion at all but the same motion viewed again. It may be compared with a film run backward. The film is not a different film but the same film viewed in reverse. This view is complementary to the previous point of view since it looks at the object unit the pixel from the datum of the object universe, whereas the previous point of view looked at the object universe from the datum of the object unit.

Sub-nuclear scale analysis of the nature of mass.

At low velocities the masses of impacting bodies remain sensibly constant so it is not possible to measure the effect on mass that may or may not result from the velocity changes accompanying elastic impact. At high velocities which are a significant fraction of the speed of light measurable changes in mass do take place and this is where the relation between mass and internal velocity must be sought. The analysis presented below is based upon that given in a previous note issued in June 1980[5].

As a point of entry to the exploration of the relation between mass and internal velocity the familiar equation relating mass at velocity v, to rest mass is assumed to be empirically correct, in other words, a reasonably accurate expression of experimentally determined relationships.

In symbols,

$$m = \frac{m_0}{\sqrt{1 - \frac{u^2}{c^2}}} \qquad \text{...........(19)}$$

The lettering in this equation differs in one respect from the usual convention. The velocity is denoted by lower case letter, u, instead of the normal representation which is the lower case letter, v. This is to keep the nomenclature consistent with that used in the previous sections.

Equation (19) can be arranged in a more suggestive form:

$$\frac{(1/m)^2}{(1/m_o)^2} = \frac{(c^2 - u^2)}{(c^2 - ?^2)} \qquad \text{..........(20)}$$

The asymmetry between the two sides of equation (18) suggests that a term is missing, specifically, a velocity, u_o.

Including the suggested missing term gives:

$$\frac{(1/m)^2}{(1/m_o)^2} = \frac{(c^2 - u^2)}{(c^2 - u_o^2)} \qquad \text{..........(21)}$$

This equation can be seen as the following two equations combined by division of corresponding sides:

$$(k/m)^2 = (c^2 - u^2) \qquad \text{..........(22)}$$

$$(k/m_o)^2 = (c^2 - u_o^2) \qquad \text{..........(23)}$$

Since, as has been mentioned in a previous section, the relationship between units of mass and units of velocity is arbitrary, k merely represents a scale constant and may be eliminated by an appropriate choice of scales. Making such a choice gives:

$$(1/m)^2 = (c^2 - u^2) \qquad \text{..........(24)}$$

$$(1/m_o)^2 = (c^2 - u_o^2) \qquad \text{..........(25)}$$

Representation of (24) and (25) on a simple vector diagram suggests that mass can be thought of as an inverse velocity, v:

$$v = 1/m \qquad \text{..........(26)}$$

$$v_o = 1/m_o \qquad \text{..........(27)}$$

Substituting for $1/m$ and $1/m_o$ in (24) and (25) and rearranging gives:

$$u^2 + v^2 = c^2 \qquad \text{..........(28)}$$

$$u_o^2 + v_o^2 = c^2 \qquad \text{..........(29)}$$

Equation (28) is the general case; equation (29) is the particular case for $m = m_0$.

These equations may be interpreted as follows. Increase in the speed of an inertial body relative to its environment characterized by a speed is accompanied by a transformation of the internal velocity, v, into an external velocity, u. In other words the external kinetic energy is derived from the internal kinetic energy or in simpler hierarchical terms, external motion is derived from internal motion. Clearly this is a more mundane and intelligible explanation for the change in inertia with increasing speed than that normally given, an explanation moreover which is fully in accordance with the behaviour of substance at a higher level as exemplified by the kinetic theory of heat.

In effect, inertial substances are seen as active not passive, as containing servomechanisms, force amplifiers. The energy put into accelerating a body is merely a control energy which is proportional to but, at non-relativistic speeds, a minute fraction of the total energy required to overcome inertial effects. As the speed of the body reaches speeds comparable with the characteristic field speed the servomechanisms become less and less effective until, at the speed of light, all the energy has to be supplied from external sources.

Time dilation

The bootstrap hierarchical analysis of the conservation laws can help in the interpretation of another phenomena associated with speeds comparable with the characteristic environmental speed, c, the phenomena of time dilation. A classic experiment on the time-dilation phenomenon was performed by B.Rossi and D.B.Hall in 1941 using the mu-mesons (muons) produced by cosmic rays entering the earth's atmosphere from outer space. In 1963 a filmed version, "Time dilation - An experiment with mu-mesons", was made by Frisch and Smith[11,12] . A second example is the measurement of the lifetime of charged pions carried out by Greenberg[13]. Such experiments demonstrate unequivocally that sub-nuclear particles take longer to decay when moving at velocities which are a significant fraction of 300,000 m/s than when they are stationary.

Looked at hierarchically this is only to be expected. It is reasonable to suppose that the nuclear decay process is connected with a characteristic internal velocity at the sub-nuclear level just as the process of biological decay, say, is connected with a characteristic internal velocity at the sub-cellular level. If, for example, the internal molecular clock of a piece of fish is slowed by putting it in a refrigerator, decay will take longer than if the fish is left in a warm kitchen.

If the sub-cellular internal velocity is regarded as a sub-cellular clock, then the decrease in velocity can be thought of as a decrease in the speed of the clock or a dilation of the sub-cellular clock time. There is nothing at all mysterious about this.

The relation between the sub-nuclear clock time and external velocity may be derived as follows:

Expressing sub-nuclear clock time as internal velocity gives

$$t = kv \qquad \text{..........(30)}$$

$$t_0 = kv_0 \qquad \text{..........((31)}$$

where t = clock reading after a given period of sidereal clock time for an inertial body moving at u.
t_0 = clock reading etc. for u_0.
k = a scale constant.

Substituting from equations (26) and (27) for m and m_0 in equation (19) and rearranging gives

$$v = v_0\sqrt{1 - u^2/c^2} \qquad \text{...........(32)}$$

Substituting for v and v_0 from equation (30) gives

$$t = t_0\sqrt{1 - u^2/c^2} \qquad \text{...........(33)}$$

But this is the accepted equation for time dilation

Present theory attributes time dilation to the existence of a metaphysical rather than a physical clock. Consequently the full implications of the experimental facts of increase in inertia and time dilation have not been properly absorbed. This is particularly important in relation to one of the most critical engineering devices, viz. nuclear reactors. Sub-nuclear internal velocity can change in one of two ways. The inertial substance can be moved relative to the environment or the environment can be moved relative to the inertial substance. Since the ambient rate of nuclear decay slows down as velocity increases, it necessarily follows that it speeds up as velocity decreases. Until it is properly understood exactly how the inertial environment governs the rate of nuclear decay it would seem that the nuclear industry is, to use a infamous parliamentary expression, sailing along with its bow doors open.

The problem is that, in spite of plain evidence to the contrary albeit at relativistic speeds, the nuclear decay process is popularly regarded as spontaneous and, as such, intrinsically unalterable like the Laws of the Medes and the Persians. This agnosticism mirrors that of the biologists of the 1850's who also believed in spontaneous generation of structures higher up the hierarchical scale until, by 1875, Pasteur's efforts freed biologists from the illogical assumptions that experimentally observed events could arise spontaneously without prior cause. Dudley has drawn attention to the extreme folly of this attitude in his "Morality of Nuclear Planning" [14]. He reminds his readers that for certain radioactive atoms the rate of nuclear decay can be affected by the state of the outermost electrons (APPENDIX II) and correctly divines the importance of this breaking of a supposedly fundamental principle. Like babies, principles either exist or they don't. As Dudley so succinctly puts it "you can't be a little bit pregnant".

Walt Patterson[15] pointed out in a radio talk given one year after Chernobyl:

"Human error enters not just in the control room but right from the conceptual design stage onwards. You can have errors in the concept of the plant, errors in its design, errors in its construction and maintenance as well as errors in its actual operation. And we have seen instances of mishaps of various kinds in various plants all over the world that have been occasioned by all of these different difficulties".

Unfortunately, the writers experience of past systems failures suggests that it will probably take a nation or more to be annihilated by synchronous and inexplicable nuclear accidents before the basic philosophical concepts on which the operation of fission reactors ultimately depend are given the serious attention that their importance demands.

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APPENDIX I

The notion of the redundancy of the translation process, the scientific laws, has been well expressed by Synge in the following passages:

"........... Faraday had a plan; he was looking for something - the laws of electricity and magnetism. He started from a firm belief that there were such laws, because deep in his blood and the blood of his contempories lay the belief in laws of nature. Not the sort of laws that you can violate and then pay a fine for violating, but immutable and inviolable laws of God that have been there from the beginning and will be there to the end, waiting for their unmasking by the humble, diligent and inquiring mind.

Faraday is dead now over 80 years. His faith and the faith of his contempories is still with us. We believe in the existence of natural laws. But there are degrees of faith and the faith of 1951 is not as simple and dogmatic as the faith of 1851. Our minds are freer but not more at ease through that freedom. To the bald question 'Do natural laws exist?' we return a curt 'Yes', because it is the best simple answer available, but in the privacy of secret meditation we ask ourselves 'What did that question mean? What do we mean by a natural law?' It is only when someone asks for a specific law governing a specific phenomenon that we shake off completely this philosophical inertia and start to search for what our deeper judgement tells us may have no meaning.

.... Thought is difficult and painful. The difficulties and pain are due to confusion. From time to time, with enormous intellectual effort, someone creates a little order - a small spot of light in the dark sea of confusion. At first we are all dazzled by the light because we are used to living in the darkness. But when we regain our senses and examine the light we find it comes from a farthing candle - the candle of common sense. To change the metaphor, the sages chase their own tails through the ages. A little child says, 'Gentlemen, you are chasing your own tails.' The sages gradually lose their angular momentum, and, glancing over their shoulders, see what they are pursuing. But most of them cannot believe what they see, and the tail chasing does not die out until a generation has passed."

Weinberg[16,17] and others no doubt, have drawn attention to the same inadequate foundations for the "natural" laws.

APPENDIX II

The following extract is taken from a contribution by Prof. Dudley to CHEM. and ENG.NEWS, Apr.7 1975, p.2.

"Long and well taught is the axiom that radioactive decay rates are described by $N = N_0 - kt$, with half-life constant $= 0.693/k$. These equations result initially from studies done with crude instruments some 70 years ago. Bluntly, they are incorrect, nonetheless appear in our latest textbooks to compound the errors of past generations. This in spite of the more recent evidence.

As a result of the development of sophisticated electronics the k of ^{7}Be was first shown (1949) to vary by about 0.1% (Be/BeO). Later (1965) the k of ^{90}Nb was altered about 4% (metal/flouride). Studies have varied the decay characteristics of 12 other radionuclides with changes in the energy state of the orbital electrons by pressure, temperature, electric and magnetic fields, stress in monomolecular layers, etc. (Emery; *Ann. Rev. Nucl. Sci.*, 1972, page 165).

The β^- emitters ^{14}C, ^{60}Co, and ^{137}Cs have had their decay characteristics altered [Anderson and Spangler; *J. Phys. Chem.*, 76, 3603 (1972); 77, 3114 (1973)]. Analysis of these results indicates that decay event A is causally related to decay event B occurring later, such that the time distributions of all decay events were no longer truly random, as required by current theory."

It has been suggested[5] that equations (28) and (29) can be interpretted in hydrodynamic terms as a manifestation on a nuclear scale of Bernouilli's Theorem which states: For any mass of flowing water in which there is a continuous connection between all the particles the total head of each particle is the same.

In symbols,

$$z_a + p_a/w + v_a^2/2g = z_b + p_b/w + v_b^2/2g$$

where datum head per unit weight of water	=	z^2
velocity head per unit weight of water	=	$v^2/2g$
pressure head per unit weight of water	=	p/w

In Bernouilli's Theorem anthropocentric concepts are used, pressure for a universe of velocities (motion on the micro-scale) and velocity for a unit of pressure (motion on the macro-scale). In equations (28) and (29) exchange between the macro- and the micro-scale was expressed in terms of velocity but it is more revealing to express the change in terms of an equivalent pressure/potential:

$$p_{uo} + p_{vo} = p_u + p_v = c^2$$

where p_u = pressure/potential equivalent to micro-velocity u^2
p_v = pressure/potential equivalent to macro-velocity v^2

In other words, a decrease in the internal velocity of a substance is equivalent to a decrease in the internal pressure and an increase in the substantial volume. This is accompanied by an increase in the external velocity equivalent to the environmental pressure and a decrease in the environmental volume. Equations (28) and (29) are thus seen to be a thinly disguised tautology, a statement that change in the volume of a substance leads to a change of opposite sign in the volume of the environment. Clearly, such a volume conservation law is prescriptive. The volume of a substance plus the volume of its environment is implicitly taken as constant, not because it is constant in any meaningful sense, but merely because this is the simplest assumption to make.

There appears to be ample evidence that changes in pressure/potential at different hierarchical levels alters the rate of radioactive decay and, by implication, the internal velocity. It is suggested that exhaustive measurements to separate out systematic from random effects, signal from noise, will provide evidence of varying rates of radioactive decay with variation in velocity relative to the governing inertial frame, the controlling "atmosphere".[2] The motion of the earth's surface relative to this frame has yet to be determined; the inertial frame of the cosmic microwave background is one obvious possibility. [18]