Physics scientists have yet to offer explanation of the cause of the “Big Bang” – how and why the universe first came into existence.

But, the nature of that first cause dictated the nature of the universe to which it gave birth; it dictated the nature of its, our, on-going physics.

This book presents the only possible physics cause of that birth of the universe and presents from it the resulting physics of our world.

It validates that cause by directly, mathematically showing how the fundamental laws of physics, heretofore obtained only empirically, arise from that birth of the universe.

BOOK 1 - MATTER

SECTION 1

The Origin of Matter: Its Cause

INTRODUCTION

In order to correctly understand the nature of matter it is necessary to consider all of the applicable sources of information and data. There are two such sources:

- The behavior of matter in its various encountered circumstances, and

- The origin of matter – how and from what it came to be.

Causality or mechanism is apparent from observation and experience which show that every thing and every event has a cause, and that those causes are themselves the results of precedent causes, and *ad infinitum*. Defining and comprehending the causality or mechanism operating to produce any contended or proposed scientific truth is essential to authenticating or validating that truth.

Until the present the science community has addressed only the first of those two with regard to the nature of matter and the omission of the second has resulted in a major error in the understanding of the nature of matter – the incorrect solution to the problem of the wave nature of matter versus its particle nature.

HOW THE UNIVERSE'S MATTER CAME TO BE

We are confronted with an apparently insuperable problem. Before the universe there was nothing, absolute nothing. That is the starting point because it naturally occurs; it is the only starting point that requires no cause, no explanation nor justification for its existence. But, that starting point has two impediments to the universe, or anything, coming into existence from it. First is the problem of change from nothing to something without, at least initially, an infinite rate of change, which is impossible. Second is the problem of change from nothing to something without violating conservation, which must be maintained.

The analysis would appear to end at that point, end with the declaration that obviously there cannot be a universe and there is no universe. Except, of course, that we and the universe we inhabit clearly exist at least enough for us to investigate it. Therefore, a solution to the insuperable problem exists. That solution is as follows.

1 - THE PROBLEM OF INFINITE RATE OF CHANGE

To avoid a material infinity the rate of change at the moment of the change must have been finite. Rather than an instantaneous jump from nothing to something, no matter how small or "negligible" that something might have been, there had to be a gradual transition at a finite rate of change. Further, the rate of change of that rate of change, the change's second derivative, at that moment had to have been finite, and so on *ad infinitum* for all of the further derivatives.

That requirement means that the form of the change had to have been either a natural exponential or some form of sinusoid. That develops as follows, in which the sought form of the change will be the function $U(t)$ [the "U" for universe, of course].

To illustrate the problem consider the function

$$(1\text{-}1)\quad \begin{array}{ll} U(t) = 0 & t < 0 \\ U(t) = t^2 & t = 0 \text{ and } t > 0 \end{array}$$

as a theoretical candidate for $U(t)$ at the beginning of the universe, which function is graphically depicted at the right.

Its first derivative, also depicted graphically to the right, is

$$(1\text{-}2)\quad \frac{dU(t)}{dt} = 0 \qquad t < 0$$

$$\frac{dU(t)}{dt} = 2\cdot t \qquad t > 0$$

and is unstated for $t=0$ because $dU(t)/dt$ is not smooth there even though $U(t)$ "looks" smooth there.

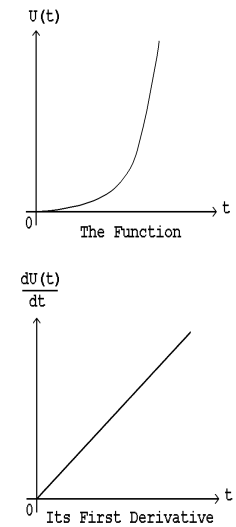

Figure 1-1a

Now, the second derivative depicted graphically to the right

$$(1\text{-}3)\quad \frac{d^2U(t)}{dt^2} = 0 \qquad t < 0$$

$$\frac{d^2U(t)}{dt^2} = 2 \qquad t > 0$$

is clearly discontinuous at $t=0$, the instant of the beginning of the universe, where it instantaneously jumps from 0 to 2 as depicted to the right.

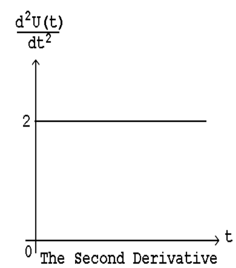

Figure 1-1b

The third derivative, which is the rate of change of the second derivative must be infinite at $t=0$ to produce the instantaneous jump from 0 to 2. Clearly, that cannot have happened in the real universe. It is such a condition which is unacceptable in a candidate function for $U(t)$ at the beginning of the universe.

The only way to avoid that condition of an infinite derivative somewhere along the line of successive further derivatives is to have a function with an endless family of finite, non-zero derivatives; that is, some derivatives may be zero at $t=0$ but there must always be further non-zero higher derivatives, which requires that the functional form of every derivative must be non-zero.

One can conceive theoretically of the idea of a function for which all derivatives are non-zero and no two are alike (in a general sense analogous to the pattern of digits in an irrational number), but it is not likely that such a function can exist. In any case the more certain and more simple way to achieve all non-zero derivatives is a repeating derivative function, the two simplest examples of which are as below.

(1-4) $$\frac{dU(t)}{dt} = \pm\, U(t)$$ [First derivative = the original function]

(1-5) $$\frac{d^2U(t)}{dt^2} = \pm\, U(t)$$ [Second derivative = the original function]

a. Analysis of Repeating Derivative Functions

Case (a): Functions Satisfying Equation 1-4

The function meeting this requirement is the natural exponential, ε^t.

(1-6) $$\varepsilon^t = 1 + t + \frac{t^2}{2!} + \frac{t^3}{3!} + \cdots$$

Taking the first derivative

(1-7) $$\frac{d[\varepsilon^t]}{dt} = 0 + 1 + \frac{2t}{2!} + \frac{3t^2}{3!} + \cdots$$
$$= 1 + t + \frac{t^2}{2!} + \frac{t^3}{3!} + \cdots = \varepsilon^t$$

so that the original function results as is required by equation *1-4*.

That is the prime case of a function that satisfies the requirement of all derivatives existing in functional form. In general those of this case are as equation *1-8*.

(1-8) $$U(t) = A\cdot\varepsilon^t$$

The function ε^t is not suitable for $U(t)$ at the beginning of the universe, however, because its value at $t=0$ is not zero. In fact it is zero only at $t = -\infty$. A function that might seem usable, however, would be

(1-9) $$U(t) = 0 \qquad t < 0 \text{ and } t = 0$$
$$U(t) = \varepsilon^t - 1 \qquad t > 0$$
$$= t + \frac{t^2}{2!} + \frac{t^3}{3!} + \cdots$$

which does have zero value at $t=0$ and otherwise meets the derivatives requirement sufficiently.

Cases (b) – (e): Functions Satisfying (1-5)

Turning to functions that meet the requirement that the second derivative equal the original function per equation *1-5* there are four such functions.

(1-10) Case (b): $$U(t) = 1 + \frac{t^2}{2!} + \frac{t^4}{4!} + \cdots$$

(1-11)
Case (c): $$U(t) = 1 - \frac{t^2}{2!} + \frac{t^4}{4!} + \cdots$$

(1-12)
Case (d): $$U(t) = t + \frac{t^3}{3!} + \frac{t^5}{5!} + \cdots$$

(1-13)
Case (e): $$U(t) = t - \frac{t^3}{3!} + \frac{t^5}{5!} + \cdots$$

These five candidate functions can be described and summarized as their exponential equivalents as in Figure 1-2, below.

Case	Function	Name of Function	Candidate U(t)
(a)	ε^t	Natural exponential	$\varepsilon^t - 1$
(b)	$\frac{\varepsilon^t + \varepsilon^{-t}}{2}$	Hyperbolic cosine	Cosh(t) - 1
(c)	$\frac{\varepsilon^{i \cdot t} + \varepsilon^{-i \cdot t}}{2i}$	Cosine	Cos(t) - 1
(d)	$\frac{\varepsilon^t - \varepsilon^{-t}}{2}$	Hyperbolic sine	Sinh(t)
(e)	$\frac{\varepsilon^{i \cdot t} - \varepsilon^{-i \cdot t}}{2i}$	Sine	Sin(t)

Figure 1-2

The relationships in the table can be verified by substitution using the formula for ε^t as given in equation *1-6*, above. Cases *(b)* and *(c)* have the same problem that case *(a)* had, that the value of $U(t)$ is not zero at $t=0$. Just as with case *(a)*, they would appear to become satisfactory if a constant, *1*, is subtracted from each of them.

These candidates all satisfactorily meet the requirement for a continuous family of derivatives so that the kind of unacceptable problem as encountered in the example of $U(t)=t^2$ at the beginning of this discussion is avoided. That is, all derivatives are finite. But, there are other requirements that the successful $U(t)$ function must meet.

b. Using the Remaining Criteria to Select U(t)

Two other criteria must be met by the successful candidate function or functions:

- the function must not be open-ended, that is it cannot ever have an infinite amplitude, and
- the function must smoothly match the $U(t)=0$ condition at $t=0$.

The first criterion eliminates cases *(a)*, *(b)* and *(d)* each of which goes to an infinite value of $U(t)$. To satisfy the second criterion the tangent to $U(t)$ at $t=0$ must be identical to the tangent to the function for $t < 0$, which is the horizontal *t-axis*. The condition is satisfied if the first derivative of $U(t)$ equals *zero* at $t=0$. Only cases *(b)* and *(c)* meet that requirement.

Therefore, the resulting form of $U(t)$, the only acceptable form, the only one that meets all of the requirements, is case *(c)*,

$$(1\text{-}14)\quad U(t) = [\cos(t) - 1] \qquad t > 0 \text{ and } t = 0$$

$$U(t) = 0 \qquad t < 0.$$

which is identical in form to the more usual and convenient equation *1-15*.

$$(1\text{-}15)\quad U(t) = U_0 \cdot [1 - \cos(2\pi \cdot f \cdot t)]$$

in which an amplitude parameter, U_0, and a frequency parameter, f, have been added.

That the only possible form for the manner in which the universe began is a sinusoidal oscillatory form would seem to be very appropriate. Oscillations, waves, are ubiquitous in our universe from oceans, violin strings and pendulums to sound, light and electron orbits. That statement can also be validly inverted: Oscillations and waves are ubiquitous in our universe because the universe began from an initial such oscillatory form.

Every oscillation that we know in nature exhibits, and the very theory of oscillations in the abstract requires, that the oscillation consist of two aspects storing and exchanging the energy of the oscillation back and forth by means of a "flow". (With one aspect varying in oscillatory fashion then when that aspect decreases there must be some "place" for its energy to go, a place in which it is stored until it reappears in that aspect when it increases again. It cannot completely disappear or be lost because the oscillation would die. That "place" is the oscillation's second aspect and it obviously must vary in a manner related to the first aspect's variation, but with its energy storage in opposite phase.

A pendulum, for example, oscillates by the motion (flow) of its swinging mass between peak height in the gravitational field (potential energy) at each end of the swing and peak speed of motion (kinetic energy) at the mid-point between the ends of the swing. Then, what is the "flow" of the original oscillation at the start of the universe ? We do not know and likely will never know but we can give it a name, *Medium*, and we can investigate its characteristics and nature.

Such was the oscillation at the beginning of the universe except that at the first half cycle the energy was in only one form increasing from zero to its maximum. Then the second form began, similarly from zero to maximum, receiving and storing the energy of the first form as that gradually decreased in the second half cycle.

2 - THE PROBLEM OF CONSERVATION – "SOMETHING FROM NOTHING"

At this point, that is the universe having started from absolute nothing as an oscillation having the form of equation *1-15*, the maintaining of conservation, the avoiding of getting something from nothing, clearly could only happen in one manner:

> There simultaneously had to have arisen an identical-in-form but opposite-in-amplitude oscillation so that the pair balanced out to the original net nothing, as in equation *1-16*.

$$(1\text{-}16)\quad U(t) = \pm\, U_0\cdot[1 - \mathrm{Cos}(2\pi\cdot f\cdot t)]$$

There is no other way that violating the assured principle of conservation could have been avoided. The universe exists. It had to come into being from a prior nothing. That had to happen while avoiding an infinity of rate of change. Conservation had to be maintained. The universe began with the oscillation of equation*1-16*.

3. The Problem: Why That Oscillation Began and What It Was

a. Why That Beginning happened

A duration is the period of time that a particular state or set of conditions persists. The duration is terminated by a change, which change also initiates a new duration. In the universe change is ubiquitous. It is the constant and continuous stream of change that makes durations mensurable. Before the beginning of the universe a duration was in process even though it was not mensurable. The beginning of the universe was the first change ever and it terminated the original primal duration of absolute nothing.

The probability of the happening of such an event is extremely small. But the event was / is not impossible. Furthermore, in the absence of that event occurring there was an extremely large duration of opportunity in which that extremely small probability could operate. In the absence of the beginning the original duration would have been infinite and that infinite opportunity operated on by minute, but non-zero, probability results in absolute certainty. The beginning of the universe could not avoid eventually happening.

b. What That Beginning Oscillation Was

The starting point is the assumption that, when the primal nothing changed as a probabilistically inevitable interruption of what would otherwise have been an infinite duration of the primal nothing, the simplest or minimum conservation-maintaining interruption that could occur is what occurred. There are two reasons for this. Occam's Razor, calls for the simplest hypothesis as the most likely. More importantly, or perhaps the same thing, if an essentially spontaneous and extremely low probability event is to occur solely as an interruption of the duration of an otherwise absolute nothing, then very little interrupting event is needed; the barest minimum of something is sufficient to interrupt, to be a change in absolute nothing. There is no call, no reason for anything more. So, while the interruption could have been otherwise, it was probably as simple and minimum as possible.

Size or amount of time are of no meaning here because there is nothing to which they can be compared or by which they can be measured. Whatever amount of change occurred is what occurred. Whatever time it took, or went on for, whatever its oscillatory frequency was, is what happened. Twice as much or half as much have no meaning.

The following conclusions about the initial oscillatory $\pm U_0\cdot[1 - \mathrm{Cos}(2\pi\cdot f\cdot t)]$ form can now be reasonably obtained:

- clearly the universe of today must be an on-going evolved consequence of its beginning, of the initial oscillatory form;

- the frequency, f, of the sinusoidal oscillation was, and is, very large; and
- the nature of the change is one of concentration or density of the something that is oscillating.
- the oscillation was spherical, radially outward in all directions from its origin, because there was nothing to constrain it otherwise.

The frequency would have to be either very large or very small -- high enough so that it is not detected or noticed by us in every day life or so low that it appears to us as no change at all in our experience.

It has already been noted that the fact that the only possible form for the manner in which the universe began is a sinusoidal oscillatory form is very appropriate because oscillations, waves, are ubiquitous in our universe from oceans, violin strings and pendulums to sound, light and electron orbits. And it has been noted that that statement can be validly inverted: oscillations and waves are ubiquitous in our universe because the universe began from an initial such oscillatory form.

If the frequency of the initial oscillation were so small that it appears to us as no change at all it would completely eliminate oscillations playing any significant part in the behavior of the universe as we know it. Therefore, the frequency must have been very large, so rapid compared to our perception that we do not notice the oscillation at all.

The change can hardly be one of gross size if it is going on right now at high frequency as has just been concluded. One can conceive of the fundamental "substance", the "something" of the universe flashing into and out of existence from a zero to a maximum density or concentration in an oscillatory fashion at a rate so high that we neither detect nor notice it at all. But, it is not possible to entertain a concept of reality flashing from zero to full size, a size that includes ourselves and our environment, in such a fashion.

Actually, the reality that we know is not "flashing into and out of existence ...." Our reality is more the oscillation itself than what is oscillating and the continuing oscillation is our steady, constant reality.

> Thus the interruption that gave us our universe was the starting of an ***oscillation*** that was ***spherical***, present to us at a very high frequency and of $\pm U_0 \cdot [1 - Cos(2\pi \cdot f \cdot t)]$ form, of the density, as the variation will be hereafter referred to, of the ***Medium***, as what it is that is oscillating will be hereafter referred to.

All of the discussion so far must apply to the "negative" oscillation, $-U(t)$, exactly as to the "positive" oscillation $+U(t)$ because the exact same reasoning as for $+U(t)$ applies to $-U(t)$ and, after all, they are not distinguishable in the discussion. The terms "$+$" and "$-$" are merely terms of convenience for two equal form opposite magnitude unknown things. We probably tend to think of our universe as the "$+$", but that is meaningless and irrelevant. There can be no objective designation of $+U(t)$ and $-U(t)$, no way to identify one versus the other. Both had to appear and our universe cannot avoid being the evolved result of both.

The universe that we know and exist in is the combined integrated result of both $+U(t)$ and $-U(t)$. The "$+$" and "$-$" electric charges of our universe [in both matter as for example in protons and electrons and in anti-matter as for example in negaprotons and positrons] must derive from that aspect of the beginning. (It is interesting to observe, also, that our universe being the integrated result of an initial beginning and its opposite relates to (presumably is the underlying cause of) the dialectical nature of reality, the ying and yang of oriental philosophy.)

The question of what the *Medium* is can only be answered in terms of its characteristics, what it does and how. Its characteristics are:

- a continuous entity, not a mass of "particles" nor anything having parts,
- simple and uniform throughout,
- of minimum tangibility or substantiality, not unlike the actuality of what we designate as “field” [electric, gravitational, etc].

4. The Problem: Why Did the Effects of Equation 1-16 Not Promptly Cancel and On-Going Absolute Nothing Resume ?

This is resolved in detail in Appendix C, *Why No Immediate Mutual Annihilation*. Briefly, the initial structure was so unstable that it promptly exploded in that which we refer to as the “Big Bang” before annhilation could occur.

5. The Problem: It Has Been Thought That the Universe Had to Start At a Point. How Could A Point Deliver a Whole Universe?

The sole reason for positing a point origin was to avoid an initial infinite rate of change. The gradualness of the *[1 - Cosine]* form resolves the problem of avoiding an infinite rate of change so that a point origin is no longer required.

The Big Bang “event horizon” problem and its relation to the development of variety in the universe has led to the hypothesis that there was an initial brief period of extremely rapid expansion called “inflation”. That hypothesis has no supporting cause nor mechanism except its role in meeting the “event horizon” problem.

But with the need for a point origin eliminated the origin can have started per equation *1-16* at any size. There was no un-accounted-for period of “inflation”. From estimates calculated of the number of particles in today’s universe it has been determined that the initial, at the very first instant, the already “inflated”‒size universe began. It was a highly concentrated volume of all of the mass and energy of the universe of about *40,000 km* radius.

That size is in terms of today’s sizes. For that event specific size is meaningless because there was nothing else to compare it to.

$\longrightarrow$