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Minneapolis, MN	August 20, 1976	"The Mechanism of the Universe"
Oxford, MS	August 19, 1977	"Twenty Years' Progress"
Salt Lake City, UT	August 18, 1978	"The Fundamentals of Science in the XXI Century"
Superior, WI	July 20, 1979	"Science Without Apologies"
Huntsville, AL	August 22, 1980	"Introduction to the Reciprocal System"
Downey, CA	August 15, 1981	"Scalar Motion"
Philadelphia, PA	August 12, 1982	"The Mythical Universe of Modern Astronomy"
Vancouver, BC	August 19, 1983	
Salt Lake City, UT	August 17, 1984	"Progress in the Reciprocal System of Theory"
Portland, OR	August 1, 1985	
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The Physical Nature of Space

Even at best it is a difficult task to convey a clear understanding of a basically new scientific concept. Regardless of how simple the concept itself may be, or how explicitly it may be set forth by its originator, the human mind is so constituted that it refuses to look at the new idea in the simple and direct light in which it is presented, and instead creates wholly unnecessary difficulties by insisting on placing the innovation within the context of previous thought, rather than viewing it in its own setting. As Freeman J. Dyson recently observed,

The reason why new concepts in any branch of science are hard to grasp is always the same; contemporary scientists try to picture the new concept in terms of ideas which existed before.

There is no easy way of overcoming this obstacle and creating a more favorable climate for unbiased consideration of the nature and merits of the innovation. About the most that one can do is to define the new concept clearly: to explain specifically just what it is, where it is introduced into the previously existing system of thought, how it differs from previous patterns of thinking, and above all, to make it clear that however strange this concept may seem to first acquaintance, it is nevertheless logical and rational. Before taking up any questions of detail, therefore, I want to make a few comments of this kind about the new ideas that I am introducing.

The basic innovation in my new theoretical system, the Reciprocal System, as I call it, is a new concept of the nature of space and time which has emerged from a long and intensive study of basic physical processes. In present-day thought, a location in space is generally conceived as an entity that can be described by means of Cartesian coordinates. Of course, we cannot see a location in space, but we can see an object which may occupy such a location and we apply the coordinates to the object. If this object remains in the same spatial location its coordinates, according to the usual concept of space, are considered to remain unchanged. It should be realized, however, that this generally accepted concept of spatial localization is not something that has been derived from physical observation or measurement; it is a *geometrical* concept—purely a human investigation—and there is no assurance that it has any physical meaning or that it corresponds to anything that exists in the physical universe.

For example, if a *physical* object existing in *physical* space has no independent motion of its own and must therefore remain stationary with respect to that physical space, we have no assurance whatever that its geometrical coordinates will remain constant. It is normally taken for granted that such will be the case, and it must be conceded that established habits of thought make it rather difficult to visualize anything different. Einstein, for instance, says that it took him seven years of study and reflection to see this matter in a clear light and to realize that a physical location might not necessarily be capable of representation by a fixed geometrical coordinate system. After coming to this realization, however, he recognized its importance and he eventually utilized it as the basis of his General Theory. In that theory the coordinate system of reference is just as impermanent and subject to modification as the measurements with respect to the reference system are in the Special Theory. As explained by Moller in his textbook on Relativity,

the spatial and temporal coordinates thus lose every physical significance; they simply represent a certain arbitrary, but unambiguous, numbering of the physical events.

What I have done in distinguishing between physical space and geometric space is thus not entirely without precedent. Einstein has already made it clear that the common assumption that they are identical is untenable. But the relation between Einstein's physical system of reference and the geometrical system of coordinates is rather vague and dependent on local factors. There is no reason, he contends, why there should be any specific relationship between differences of coordinates and measurable lengths and times. As a result his system is extremely complex mathematically and almost impossible to check against observational data except in certain artificially simplified situations. On the other hand, the relation between my physical system of reference and the geometrical system is specific and definite under all conditions, and it is therefore possible to convert values from one of these systems to the other by relatively simple mathematical processes.

When viewed from the standpoint of a fixed geometrical system of reference, each location in the physical space defined by my postulates moves outward from all other locations in space at unit velocity—one unit of space per unit of time. Any physical object without an independent motion of its own remains in the *same location in physical space* permanently, but the spatial locations themselves move with respect to the geometrical coordinate system, carrying with them whatever objects exists at these locations, hence such objects move steadily outward away from each other when viewed from a fixed reference system.

According to this new concept, a location in physical space is a specific and definite entity, but it cannot be defined by static coordinates in the manner in which we define positions in geometric space. Physical space, the space which actually exists in the physical universe, and which enters into physical events and relations, is a dynamic entity, analogous to an expanding balloon, or more accurately, since it is three-dimensional, to an expanding solid rubber ball. Physical objects that are located in that physical space may have independent motions of their own, just as particles might move about on the surface of a balloon or through the voids in the structure of a rubber ball, but irrespective of whether or not they are moving in this manner, each of the objects is continually moving away from all others because of the continuous expansion of space.

Of course, this new concept of physical space as an entity in motion is so foreign to current thinking that it seems very strange on first acquaintance, but it is nevertheless obvious that it is a wholly rational hypothesis. Furthermore, the postulated expansion, or progression, of space is something that can be observed directly. As pointed out earlier, the identification of physical space with geometric space in current practice is not something that has originated from physical observation; it is purely hypothetical. To be sure, there are objects in the local environment which for extended periods remain stationary with respect to a geometrical system of reference, but these are not objects without independent motion. On the contrary, each of them has a whole system of motions. They participate in the rotation of the earth, in the earth's motion around the sun, in the motion of the solar system around the center of the galaxy, and in an unknown amount of motion of the galaxy itself, in addition to which they are subject to the influence of gravitation, which affects the motion of these objects to an unknown degree. It is possible, however, with the aid of today's powerful instruments, to see objects which are so distant that any motions of this nature which they may possess are negligible (that is, unobservable) and the effect of gravitation is attenuated to the point where it is no longer a significant factor. Under these conditions the new theory says that we should find these objects being carried away from us and from each other at extremely high velocities by the progression of physical space. This is exactly what the astronomers tell us that they see when they observe the most distant galaxies within reach of their giant telescopes.

It is important to realize that the motion due to the progression of space is something of an entirely different character from the independent motions of the objects that exist within the expanding system. If there are three objects A-B-C in a line, an object B moves *away from* A in the normal manner, it moves *toward* C. This is a directional motion: a vectorial motion in three-dimensional space. But if these are three objects that are being carried outward by the progression of space—three galaxies, let us say—then the motion which carries object B *away from* A moves it *away from* C as well. In the case of the motion is outward away from *all* other locations, hence it is *scalar*: a motion with no specific direction.

Astronomers recognize that the motion of the distant galaxies has this scalar character, and they frequently use the analogy of the expanding balloon, but in current thought this galactic motion is regarded as a unique phenomenon requiring a special explanation of its own, whereas in the Reciprocal System this is merely one manifestation of a *general* phenomenon which is encountered in a wide variety of circumstances throughout the universe. According to this new system of theory, *any* physical object which has no independent motion of its own will move outward in the same manner unless it is restrained in some way. Many of the most important of the new conclusions reached in the development of the Reciprocal System have originated from the discovery that certain phenomena hitherto regarded as involving ordinary vectorial motion are actually manifestations of scalar motion of the progression type.

A related point of major significance to physical theory that is brought out clearly by the balloon analogy is that the datum from which all physical activity extends is not zero but the speed of the expansion. It is evident that if we are concerned with the magnitude of the independent motion of a particle on the surface of the balloon, it is not the measured speed that is significant; the meaningful quantity is the difference—plus or minus—between this measured speed and the speed of the expansion. Similarly, the significant quantity in the physical universe is the deviation from the speed of the expansion (the speed of light), not the deviation from zero.

Here is one place where the new theory leads to some modification of previous mathematical relations, but it should be understood that the *essential* difference between the new theoretical system and previous scientific thought is *conceptual*, not *mathematical*. The requests that are frequently made for a mathematical statement of the new theory are therefore meaningless. To illustrate this point, let us give some further consideration to the outward movement of the distant galaxies—the galactic recession. There are two theories of this recession currently in vogue among the astronomers: the "big bang" theory, which attributes the existing galactic velocities to a gigantic explosion that is presumed to have taken place billions of years ago, and the "steady state" theory, which postulates that the galaxies are being pushed apart by new matter that is being created in inter-galactic space. To these I have now added a third. My new theoretical system says that the galaxies are actually stationary in physical space (except for some random motions that are too small to be observed), but that they are being carried outward with reference to fixed geometrical coordinates because physical space itself is an expanding system.

So far as the galactic recession itself is concerned, there is no significant mathematical difference between these explanations and hence there is no mathematical basis for preferring one of them over another. The real test of the relative power of these different hypotheses is the extent to which they are able to throw additional light on related questions, and for this purpose it is the *interpretation* that we put upon the mathematical expressions—our concept of the *physical nature* of the recession—that is significant. Mathematical reasoning or manipulation of symbols cannot take us beyond the bounds that are set by our concepts of the physical realities that are represented by the mathematical expressions or symbols, and in the case of present-day theories of the galactic recession these boundaries are narrow indeed.

But when we turn to the new concept of the recession that is supplied by the Reciprocal System we find that this opens up an immense new field for investigation. One very important point which immediately becomes obvious is that *on the basis of this concept both the recession and the inverse of this phenomenon may occur coincidentally*. This is not possible in a universe that behaves in accordance with current cosmological theories. We obviously cannot have the explosion postulated by the "big bang" theory and the reverse process—an "implosion" as it is sometimes called—going on simultaneously. Before the idea of concurrent inward and outward motions could be conceived at all, it was necessary to have a totally new concept of the nature of the recession, such as that which has been provided by the Reciprocal System.

If, as that system contends, objects with little or no independent motion, such as the distant galaxies, are being carried outward by the progression of space itself, then it is clearly possible for objects which *do* have substantial independent motions to move in the direction opposite to the progression of space, and thus move steadily inward toward each other. Such objects will then appear to be exerting forces of attraction upon each other, but because they are actually independent scalar motions rather than forces they will have some extraordinary characteristics, quite unlike those of the forces of our everyday experience. In particular, they will act instantaneously, without an intervening medium, and in such a manner that they cannot be screened off or modified in any way. All of these are, of course, the observed characteristics of gravitation, and it is apparent that the behavior of aggregates of matter in the observed physical universe agrees exactly with the theoretical behavior of objects that have independent motions in the direction opposite to that of the space progression.

We thus find that by a purely *conceptual* change—a modification of our ideas as to the fundamental nature of space—without any alteration of previously established mathematical relationships, we are able to extend our explanation of the galactic recession to apply to gravitation as well, thus bringing these two important physical phenomena within the scope of the same general theory. So it is throughout the universe. Each advance of this kind that we make with the aid of the new concept of the nature of space opens the door to further advances in related fields. Identification of gravitation and the galactic recession as two manifestations of the same basic phenomenon leads immediately to complete and consistent answers for many of the most serious problems that now confront the astronomers—explanations of the origin of galaxies, the stability of the globular clusters, the immense distances between the stars, and so on. Then further development along the same lines enables clarification of relations in areas that lie farther afield, such as the cohesion of solids and liquids, for instant. Thus a whole theoretical universe gradually emerges as we build item by item on the new conceptual foundation.

—*Dewey B. Larson, London, June 1966*

THE MECHANISM OF THE UNIVERSE

The human race, in its modern form, has been observing the universe from the surface of this planet for something like 50,000 years, perhaps as much as 100,000. But only within the last three or four thousand years has it had the capacity to analyze these observations and arrive at conclusions as to their significance. Yet on the basis of this extremely limited experience we somehow feel that we are competent to investigate events which, if they happened at all, happened ten or twenty billion years ago, and other events which, if they are ever going to happen, will not happen for an equally long time into the future.

This highly presumptuous undertaking, which goes by the name of cosmology, has thus far been left mainly in the hands of two special groups: the astronomers, who are the only ones that deal with objects and processes that persist over long enough periods of time to throw any light on the points at issue, and the theologians, who are the only ones that claim to have sources of information independent of experience. Since our discussion will be concerned with the scientific aspects of the subject, it will not be feasible to give any consideration to the religious contentions and to the non-scientific evidence that is offered in support of those contentions. It will be appropriate, however, to take a brief look at the information from which the astronomers are deriving their theories.

From the planets, particularly the one that we know best, the one on which we live, we obtain one very significant item of information. It is now clear that the earth is undergoing some changes of an irreversible nature—what we rather loosely call evolutionary processes. This point may not seem very significant, as it is now taken for granted. One should bear in mind, however, that it was not always taken for granted. On the contrary, during almost all of the history of the human race the belief was that both the earth and the heavens are fixed and unchanging. The definite evidence of the existence of irreversible processes on the earth is important because it is positive proof that the universe is not fixed and immutable; it is a universe of change.

Another result of the studies that have been made of our own planet is an indication of the time scale of events in the universe. By extrapolating the rates of some of the irreversible changes, such as radioactive disintegration, back to some assumed base condition, it has been found that there was a discontinuity of some kind about four or five billion years ago. This has been interpreted as representing the time of formation of the earth. Here, however, we encounter something that we need to watch out for, whenever we are attempting to assess the validity of scientific conclusions. If we examine the nature of the argument in this case, we find that the conclusions do not follow logically from the premises. Radioactivity is not a property of the earth as an aggregate; it is a property of the radioactive matter. If the calculated zero point indicates an age, it therefore indicates the age of the matter, not the age of the earth. This conclusion is not acceptable to present-day scientists, so they substitute one that is more to their liking. We should disregard it, and recognize that the observations actually tell us nothing beyond the fact that there was a discontinuity of some kind four or five billion years ago. For present purposes, that is sufficient, as it establishes the fact that we are dealing with objects and processes that persist through billions of years.

The definite knowledge that this is a universe of change becomes very important when we move from planets to stars, because there is little opportunity for direct observation of the changes that are taking place there. The time scale of astronomical events is so long that our observations give us little more than an instantaneous picture. But there are aspects of this picture that suggest change, and the knowledge that changes do take place justifies us in concluding, at least tentatively, that the indications of change are not misleading. However, our ideas as to the nature and directions of the changes have to be based mainly on assumption and inference. For example, stars come in a great variety of sizes and temperatures, but the great majority of them can be placed in a regular pattern known as the main sequence. In a universe of change there is good reason to believe that this is an evolutionary pattern of some kind, but unfortunately the pattern itself gives us no clue as to the direction of the evolution. It does not tell us which are the old stars and which the young. For an answer to this question we must examine some collateral data.

When we attempt to do so, however, we encounter one of the major problems of astronomy, and the astronomical view of cosmology. These collateral items to which we turn for a resolution of the question do not agree. In fact, as I will bring out later in the discussion, most of the purely astronomical evidence contradicts the prevailing astronomical opinion. What has happened here is that a very tentative conclusion as to the source of the energy of the stars that has been reached by the physicists has been accepted by the astronomers as incontestable, and has been allowed to override the astronomical evidence. The physicists have spoken; let no dog howl.

This is an example of another of the things we have to guard against when we undertake a critical examination of any field of knowledge: a tendency to magnify the observational information in transmission between the isolated compartments in which today’s specialists work. The physicists know that their conclusions in this case are far from secure, and it is probable that those conclusions would be thrown overboard quickly if it developed that they were in conflict with any physical information, but by the time they have been passed on to the astronomers they have acquired the status of Holy Writ, and any doubt as to their validity is unthinkable.

A similar process of enhancement takes place whenever highly questionable assumptions are subjected to advanced mathematical treatment. By the time the original data have been put through a half dozen esoteric mathematical processes and an answer of some kind has been obtained, it is all too often forgotten that the whole construction rests on nothing but the thin air of an assumption. I am emphasizing these points because the biggest obstacle that stands in the way of arriving at an understanding of the remote regions and features of the universe is the existence of so many errors and misconceptions in what currently passes as knowledge. As one American humorist put it, some years ago, "It isn't what we don't know that hurts us; it is what we do know that ain't so."

In addition to the information that we get from the stars individually, the observations of stellar groups, clusters, as we call them, provide some further clues as to the nature of the evolutionary processes in which they are participating. Indeed, the clusters have been more informative on the subject of the direction of evolution of the stars than the stars themselves. Here again, however, it is by no means certain how the observational information should be interpreted, and consequently its significance has been open to serious question.

When we step up to the next larger aggregates of matter, the galaxies, we again find some similar patterns that shed some light on the cosmological question. This completes the astronomical contribution to the solution of the problem, aside from one new factor that has come to light very recently. But strangely enough, these astronomical observations, which constituted the entire basis for cosmological speculation until a few years ago, are now almost totally disregarded. Current cosmological theories make no attempt to connect the evolution of the contents of the universe—the galaxies, the clusters, the stars, the planets, the independent particles, and the non-material constituents—with the evolution of the universe as a whole.

The recent findings on which cosmological attention is now concentrated are those which show that the wavelengths of the radiation received from the distant galaxies are strongly shifted toward the red end of the spectrum. If these red-shifts are interpreted as Doppler shifts, the only adequate explanation that is currently available, the distant galaxies are receding from us at extremely high velocities which increase linearly with the distance. This indicates that the entire universe is undergoing a process of expansion. Obviously any cosmological theory must provide some kind of an explanation for the expansion, as it is clearly a significant feature of the cosmological pattern. As matters now stand, however, the cosmologists are concentrating their attention almost entirely on this one phenomenon, as if it were the whole problem. It would not be too far from the truth to say that the current theories of cosmology are nothing more than theories of the galactic recession.

If scientific questions were settled by majority vote, the winner in the cosmological race at the present time would be what is rather irreverently called the Big Bang theory. This theory accounts for the recession by extrapolating the observed rate of recession back to zero and assuming that at the time thus calculated, some ten or twenty billion years ago, all, or most, of the matter in the universe was contained in one dense mass, which, for some reason, exploded and ejected its contents at the high velocities that we now observe. The ultimate fate of the universe, on this basis, will be a situation in which all activity will cease because the constituents of the universe will be too widely dispersed to interact.

A variation of the Big Bang theory assumes that the forces of gravitation will ultimately overcome the outward motion, and will initiate a contraction that will terminate when the maximum density is again reached, whereupon a new Big Bang will occur. This oscillating theory visualizes a continual series of such cycles without a beginning or an end.

In the Steady State theory, the effect of the recession in moving the galaxies apart is offset by the continuous creation of new matter which forms new galaxies to fill in the vacant spaces resulting from the expansion, so that the universe, while always changing, always remains essentially the same.

All of these theories are subject to serious objections. The Big Bang is the least open to specific charges of error or inconsistency, but this is mainly because the theory consists almost entirely of untestable ad hoc assumptions. Of course, this is, in itself, a serious defect in the theory. The oscillating theory is subject to the same objections as the Big Bang theory, with the additional complication that it requires gravitation to be strong enough to eventually overcome the recession, whereas the indications are that the gravitational force is much too weak.

The strongest theoretical objection to the Steady State theory comes from those who are unwilling to sacrifice the conservation laws by admitting the continuous creation of matter that this theory requires. The history of the theory has been one of alternating rise and fall as additional evidence has accumulated. At the moment its fortunes are at a low ebb because of two recent developments of an adverse nature. The first of these comes from investigations of the relation of the number of astronomical radio sources to the distance. On the basis of these radio source counts it is now believed that the universe was more densely populated some billions of years ago than at present. This, if correct, would rule out the Steady State theory. Another item that is currently being given much weight is the discovery of an isotopic background radiation that is more or less consistent with the Big Bang and oscillating theories but is as yet unexplained by the Steady State theory.

Neither of these new findings is at all conclusive, so far as the validity of either theory is concerned. The radio source counts are open to serious question, particularly since no one knows with any degree of certainty just what kind of objects are being counted. Likewise, the possibility of an explanation of the background radiation that is consistent with the Steady State theory is by no means excluded. Nor is the explanation of the cosmic background radiation in terms of the Big Bang theory as good as is claimed; it is now conveniently forgotten that the temperature of the background originally predicted by the Big Bang cosmologists was significantly higher than the observed value. In any event, it should be recognized that disproof of one theory is not equivalent to proof of another. Even if the new observations are accepted at their face value, they contribute nothing toward establishing the validity of the central assertion of the Big Bang theory: the assertion that the recession of the galaxies is due to a primeval explosion.

This is the cosmological situation at the moment. For an overall appraisal of just how matters now stand I will quote two prominent scientists:

> This job—cosmology—starts with rigorous analysis and ends in flights of imagination. (Vannevar Bush)
>
> All chains of reasoning in cosmology are elastic. Almost every observation interpreted to support one conclusion can, in the hands of a moderately adroit theoretician, be interpreted to support the opposite. (Irwin I. Shapiro)

I am going to present a look at this situation from a new direction. This new view will not utilize any of the information that the astronomers have gathered from their observations. Where I refer to this information at all, it will be only for purposes of comparison with the results that have been obtained theoretically. Nor will I make any use of the information that the ecclesiastics claim to have received through revelation of one kind or another. Instead, I will present a view that is derived entirely by deduction from basic physical premises. This view is now open to us because we have at our disposal a general physical theory—the theory of the universe of motion.

The most primitive condition in a universe of motion, the condition in which the universe is in existence, but nothing at all is happening, is one in which nothing exists but independent units of motion. Each such unit involves one unit of space in association with one unit of time, and the speed is therefore 1/1 or unity. This means that the physical datum, or reference level, on the natural basis, the basis to which the universe actually conforms, is not the mathematical zero, but unit speed.

Let us consider an object which has no capability of independent motion, and is not acted upon by any outside force. If this object occupies a spatial location, which we may call s, at some time t, then, since it cannot move, it must remain at the same location indefinitely. But in a universe of motion this object is not motionless with respect to the arbitrary stationary system of reference that we customarily utilize—it is motionless with respect to the natural system of reference. That natural system is moving outward at unit speed with respect to the stationary system, carrying all physical objects with it. Thus, the object in question does not remain at the point in a stationary reference system which we have called s. It moves outward from that location at unit speed, so that at time t+l it occupies spatial location s+l.

Some may find this difficult to reconcile with their present beliefs. We are accustomed to viewing motion in the context of its relation to a stationary spatial frame of reference. If an object has no capability of independent motion, then it seems almost axiomatic to most that its speed is zero with respect to that stationary reference frame. But there is no good reason why the universe must necessarily conform to human ideas as to what is right and proper. The general physical theory that we have developed, a theory that describes how the universe actually behaves, not what any of us thinks is the way it ought to behave, tells us that, in addition to whatever other motions it may possess, every object in the universe is moving outward at unit speed away from all other objects, simply by reason of the motion of the natural reference system relative to the stationary system that we have arbitrarily selected as a frame of reference.

Here we have a very important conclusion that, as I have shown, is derived purely by deduction from the general properties of a universe of motion. It will not be possible to follow the lines or chains of deductions leading to other conclusions in this same detailed manner on this occasion. For present purposes I will merely indicate the points at which we will have to go back to the basic premises and follow a new chain of deductions, and I will specify the conclusions that are thus reached, to the extent that they are relevant to the subjects under discussion. The full details of the theoretical development are available in my publications and those of my associates.

One of these additional lines of deductions from the basic premises arrives at the conclusion that atoms of matter are combinations of rotational motions, and that the nature of these atomic rotations is such that they have a translational aspect. As an analogy, we may consider a ball rolling along the floor. This ball does not have an independent translational motion, as it would if it were flying through the air while rotating. It has no motion other than the rotation, but the effect of this rotation, under the particular circumstances, is to move the ball forward translationally. A further finding from the same chain of deductions is that the translational motion due to the atomic rotation necessarily opposes the outward progression of the natural reference system. Thus, in addition to the outward motion due to this progression, every atom or aggregate of matter is subject to an opposing inward motion. This inward motion is what we know as gravitation.

It has long been recognized that there are many physical phenomena that are not capable of satisfactory explanation on the basis of the only universal force (or motion, which is another way of looking at the same thing) that has heretofore been recognized; that is, gravitation. For example, Gold and Hoyle make this comment:

> Attempts to explain both the expansion of the universe and the condensation of galaxies must be very largely contradictory so long as gravitation is the only force field under consideration. For if the expansive kinetic energy of matter is adequate to give universal expansion against the gravitational field it is adequate to prevent local condensation under gravity and vice versa. That is why, essentially, the formation of galaxies is passed over with little comment in most systems of cosmology.

Karl K. Darrow made the same point in connection with the question of interatomic equilibrium in the solid state, emphasizing that one force alone, whatever it may be, is not sufficient. There must also be what he called an “antagonist”. Darrow went on to say, “This essential and powerful force has no name of its own. This is because it is usually described in words not conveying directly the notion of force.”

The globular star clusters provide still another example of the same kind. Like the formation of galaxies, this situation is “passed over with little comment” by the astronomers, but E. Finlay-Freundlich discussed it at length in a publication of the Royal Astronomical Society some years ago. He noted that gravitation is the only force available to the theorist, and on this basis, he says, “the main problem presented by the globular clusters is their very existence as finite systems.”

Identification of the “antagonist” to gravitation, the outward progression of the natural reference system, not only resolves these specific problems, but also throws new light on many other physical situations. An important point in this connection is that the net resultant of the two opposing motions varies with the distance. The inward motion due to the atomic rotation originates at the specific locations occupied by material aggregates, and it therefore decreases with distance in accordance with the inverse square law. The outward progression of the reference system is effective everywhere. It follows that at the shorter distances the gravitational motion is the greater, and all objects continually move toward each other, unless they are subjected to external forces. As the distance increases, the gravitational motion decreases, and at some point reaches equality with the outward motion of the reference system. Beyond this point the net motion is outward, increasing toward the speed of light as the gravitational effect is continually attenuated.

Here, in these immediate consequences of the concept of a universe of motion, we have an explanation of the recession of the galaxies that comes directly out of basic theory, and requires no ad hoc assumptions. But it should now be evident why I raised the question with respect to the current belief that the answer to the galactic recession is the answer to the whole cosmological problem. The explanation of the recession at which we have arrived does not solve the problem; it merely rules out the ad hoc assumptions that have been made, and thereby deepens the mystery. The ultimate fate of the receding galaxies is still a wide open question, and the origin of the galaxies is more of a problem than before. Continuous creation is inconsistent with the basic elements of the new theory, and the Big Bang concept is eliminated from consideration, as the recession has been identified as due to a different cause. But the galaxies that formerly occupied the regions just beyond the gravitational limits have moved away, and yet there is no additional vacant space. Where did the present occupants of these regions come from?

We can approach this question most conveniently in a sort of roundabout way. Another line of deductions from the basic postulates, an extension of the deductive chain from which we arrived at the nature of the atomic structure, discloses that this this atom is subject to an age limit. When an atom of matter arrives at the limiting age its rotational motion reverts to the translational status; that is, the atomic mass is converted to energy. A further line of deductions leads to the conclusion that most of the oldest matter accumulates in the interiors of the largest galaxies. The attainment of the age limit on a massive scale in one of these giant galaxies results in a tremendous explosion, which accelerates portions of the remaining mass of the galaxy to a speed in excess of the speed of light. The question then becomes, What happens to this fast-moving matter?

For an answer to this question we need to return to the fact previously deduced that space and time are the two reciprocal aspects of motion, and nothing else. This means that the reciprocal relation is a general relation that is effective throughout the universe. An immediate consequence is that for every physical entity or phenomenon there necessarily exists another entity or phenomenon that is similar in all respects except that space and time are interchanged. The inversion may be only partial, applying to only one of the motions involved — the translational motion, for example — or it may apply to all of these motions. All of the familiar entities of our material universe are therefore duplicated in the inverse manner, which leads to the conclusion that what we have been regarding as the physical universe is actually only one half of the physical universe as a whole. There also exists an exact duplicate, differing only in that wherever space is involved in any of the phenomena of our material sector, the inverse, or cosmic sector, as we will call it, substitutes time. Where we have time, it has space.

The next question that naturally arises is, Where is this cosmic sector of the universe? Here we need to look at the speed magnitudes. As already brought out, the natural reference system is moving at unit speed, which we can easily identify as the speed of light. In our material sector the prevailing speeds are less than unity, and the result is motion in space. In the cosmic sector, where space and time are interchanged, the speed is greater than unity, and the result is motion in time: a change of location in three-dimensional time that is analogous to the changes of location in three-dimensional space that result from motion at speeds less than unity. Thus each of the structures of the cosmic sector—the cosmic stars, cosmic galaxies, etc.—is separated from us by a certain amount of time, just as there are spatial separations between our location and the various structures of the material sector.

We receive the same kinds of information from the cosmic sector that reach us from the distant regions of the material sector: (l) radiation, and (2) individual particles of matter. But gravitation in the material sector is a motion in space, and it produces aggregates in which the constituent atoms are contiguous in space but widely dispersed in time. The radiation received from such an aggregate is therefore highly concentrated in space, and since we are approximately at rest in space relative to the emitting aggregate, we can recognize the radiation as coming from a discrete object. However, gravitation in the cosmic sector is a motion in time, and it produces aggreqates in which the constituent atoms are contiguous in time but widely dispersed in space. The radiation from these aggregates reaches us from the widely dispersed spatial locations, and instead of being concentrated in the manner-of radiation from a material star or galaxy, it is spatially isotropic. This is the background radiation that has been interpreted as evidence in favor of the Big Bang theory. We likewise encounter cosmic stars and galaxies from time to time, but because of the way in which their constituents are dispersed in space we encounter them as occasional single cosmic atoms rather than as aggregates.

At this point I must report, rather regretfully, that the Reciprocal System of theory is a great disappointment to the devotees of science fiction. Many of them are full of anticipation when they first hear that the theory involves motion in time, but their hopes are dashed when they find that time travel in a universe of motion is subject to exactly the same kind of limitations as space travel. If we have sufficient time at our disposal, we can always return to a specific location in space by means of space travel, but we cannot return to the same place at the same time: we can only get there at some later time. Similarly, by means of travel in time, it would be possible, in principle, to return to any time location, but we cannot return to the same time at the same place, we can only reach that time location at a distant place.

We likewise have to say no to anti-gravity devices. Superman will have to stay in the comic sections. Gravitation is a motion, and the only anti-gravity device is an opposing motion. Now I will have to deepen the gloom by consigning the anti-matter energy generators to the same discard pile. There are aggregates of anti-matter (or cosmic matter, as we prefer to call it) to be sure. There are anti-matter stars, clusters and galaxies. But these are aggregates in time, not in space, and we meet them only one atom at a time.

To make matters worse, we will also have to discard what we may call the sanctified science fiction, the many products of the imagination ranging from the fanciful to the fantastic that have been injected into conventional physical and astronomical theory by investigators and theorists who have been frustrated in their attempts to solve their problems in an orderly scientific manner. Such ad hoc concepts as black holes, quarks, the Big Bang, curved space, etc., are no more scientific than anti-gravity devices. They have no place in the new system. In fact, this system outlaws ad hoc assumptions altogether.

Returning to cosmology, we now have the answer to the question as to the fate of the galactic fragments thrown off at speeds greater than the speed of light by the explosion of the galaxy. These fragments are observable for a time until the effect of gravitation is overcome, after which they enter the cosmic sector, the region of speeds above unity, and the matter of which they are composed then becomes available for the building of cosmic galaxies. These galaxies recede from each other, they and their constituents age, just as the material galaxies and their constituents do, and eventually the oldest cosmic galaxies explode and eject fragments at speeds less than unity. The fragments enter the material sector and become available as the raw material from which new galaxies are formed.

This, then, is the answer for which cosmology has been looking. As the proponents of the Steady State theory have contended, the universe had no beginning, and it will have no end. It has always existed in essentially the same form, and it has essentially the same appearance from any point in space or any point in time. But there is no continuous creation, nor do the galaxies simply disappear over the “time horizon,” as in the Steady State theory. In a universe of motion the large-scale action of that universe is a cyclic process. Each half of the universe goes through an evolutionary sequence that begins with the entrance of matter from the inverse sector, transforms this matter into compatible structures, gathers it into aggregates, separates the aggregates, and finally subjects them to phenomena that result in the ejection of matter back into the inverse sector. A similar process in that sector completes the cycle.

For the benefit of those who may be reluctant to accept the idea of a universe without beginning or end because of a conflict with the religious idea of an act of creation, I will say that our findings do not affect the creation issue one way or the other. If the universe of motion came into being through an act of creation, then space and time were the entities that were created. There could be nothing before time existed, and if it came into existence as a result of an act of creation, the universe that was created could just as well be cyclic as open-ended.

Having established the general nature of the cosmic cycle, let us now take a closer look at its principal features. One of the advantages of a general physical theory is that the deductions we make from it do not have to be confined to generalities. We can go into as much detail as we wish, or, in this case, as much as we have room for. The matter ejected from the cosmic sector arrives in the material sector in the form of atoms of the cosmic elements, together with sub-atomic particles. The current belief is that these incoming particles, the cosmic rays as they are called, are atoms of the material elements, but the available means of identifying the original cosmic rays are not capable of distinguishing between the cosmic and material atoms. Furthermore, the subsequent behavior of these particles shows that they are not ordinary material elements. If they were, they would maintain their identities at least until they made some violent contact with other matter. But this is not what happens. If these atoms do not make contact quickly, they disintegrate spontaneously.

This is not the place to give a detailed account of the complex process by which the cosmic elements are transformed into structures that are compatible with the material environment. I will merely say that the end product is hydrogen, and this new hydrogen is the raw material from which the new structures of the material sector are built.

It is recognized by the astronomers that any evolutionary theory of the universe must regard the aggregates of matter such as stars and galaxies as having been formed by condensation from dispersed matter. But just how this can take place is a difficult question that, as Gold and Hoyle pointed out in the statement that I quoted earlier, they prefer to avoid. But the continual arrival of new supplies of hydrogen derived by modification of the cosmic matter received from the cosmic sector provides the answer to this problem.

Let us consider a spherical volume of space containing a uniform distribution of hydrogen atoms and sub-atomic particles. These particles, small as they are, are subject to the same two basic forces, or motions, that account for the translational behavior of the galaxies. The outward progression of the reference system carries each particle away from all others, while at the same time the gravitational motion carries all of them inward toward each other. The outermost particles of this spherical volume of matter are subject to the gravitational effect of the entire mass, as well as the interactions with their immediate neighbors, but in relatively small volumes the progression still predominates, and the aggregate tends to expand. As larger and larger volumes are taken into consideration, however, the mass, and consequently the total inward force, increases as the third power of the radius, whereas the effect of distance is a second power function. At some very large volume, therefore, the total gravitational motion of the outer particles exceeds the progression, and the entire aggregate of diffuse matter arrives at an equilibrium between the inward and outward motions.

Such an aggregate still has no unbalanced force that would cause it to contract, but the continual introduction of additional matter from the cosmic sector changes the situation, inasmuch as it strengthens the gravitational forces and moves the equilibrium inward. As this contraction of the volume occupied by the aggregate continues, and the density of the enclosed matter increases, local aggregates begin to build up within the occupied volume, and the ultimate result is a globular cluster, in which a million or more stars form a spherical aggregate.

The globular clusters have been an astronomical puzzle of long standing, as it is quite evident that they are stable and long-lived structures, but no adequate explanation has been available as to why the gravitational forces that hold such a cluster together do not cause its constituent stars to coalesce into one single mass. The progression of the natural reference system supplies the answer to this problem. The globular cluster is still subject to the same considerations as the spherical aggregate of diffuse matter from which it was formed. Like the interior particles of the diffuse aggregate, each of the stars in the interior of the cluster has a net outward motion. But the outer stars have net inward motions, and an equilibrium is established between these inward and outward motions.

The region under the gravitational control of a star within the cluster meets the region under the control of its neighbor at a point where the gravitational force of each star is near the minimum. Each star is therefore outside the gravitational limit of its neighbor, and because its net balance of motions is outward, it can never get inside this limit. The diffuse aggregate from which the globular cluster was formed contacts its neighbor at a point of maximum gravitational force, and the gravitational limits of neighboring aggregates therefore overlap. The increase of mass due to the incoming cosmic matter extends the limits still farther, and by the time the globular cluster stage is reached, each cluster is well within the gravitational limits of one or more of its neighbors. The clusters therefore move toward each other, and eventually some of them make contact.

The prevailing opinion is that because of the immense distances between the stars, the stellar aggregates participating in such an encounter would pass through each other with no significant interaction. Our findings indicate that this view is incorrect. Inasmuch as the stars of the cluster occupy equilibrium positions, the aggregate has the general characteristics of a liquid, and the actual result of contact is an amalgamation of the clusters. The resulting combination, with a population of two or three million stars, is classified as a dwarf galaxy. Its larger mass, as compared to that of the original cluster, greatly increases its gravitational force and improves its ability to capture additional clusters. If it keeps out of the clutches of still larger galaxies, the small galaxy ultimately becomes a large galaxy.

This picture of the situation is in direct conflict with much of current astronomical thought. Although no consensus has been reached on the issue as to how, and under what circumstances, condensation from the original diffuse matter occurred, conventional theory regards the galaxies, rather than the globular clusters, as the original products of the condensation process, and views the globular clusters as very old features of the galaxies. According to our findings by deduction from fundamental physical theory, the stars of the globular clusters, instead of being the oldest of those that are optically visible to us, as conventional theory asserts, are the youngest of the observable stars. In view of this direct conflict, it would be of interest to review the available evidence to see just how well each of these conflicting theories agrees with the information from observation. Unfortunately, the remaining space will not permit a detailed review of this kind, but I can say that I made a critical comparison of the two conflicting explanations of the status of the globular clusters a few years ago, in which I examined the assertions of each theory with respect to fifteen sets of facts which can be considered to represent practically all that is now known about the clusters.

In this investigation I found that conventional theory furnishes fully acceptable explanations for three of these fifteen items, partially satisfactory explanations for three more, unsatisfactory explanations for three items, no explanation at all for four items, and is definitely in conflict with the facts in two cases. The deductions from the postulates of the Reciprocal System, on the other hand, furnish full and detailed explanations for every one of these fifteen items. While, as I said, space does not permit a full discussion of these results, I am rather reluctant to make statements such as the foregoing without at least some substantiation, and I will therefore comment briefly on two of the items, to give an idea of the basis for my conclusions.

First, let us consider the motions of the clusters. In the words of Struve, they move "much as freely falling bodies attracted by the galactic center." Our theory says that this is exactly what they are and how they should move. Conventional theory is able to explain such motions only on the basis of some highly implausible assumptions.

As an illustration of another type of pertinent information, observations of the star clusters within the galactic disc show that these groups are not stable, and are disintegrating at a relatively rapid rate. The large number of such clusters now in existence in spite of the short indicated life means that some process of replenishment must be operative. Our theoretical development tells us that the supply is replenished by globular clusters which fall into the galaxy and break up.

The astronomers have no explanation at all. Bok, for example, says “we do not pretend to know from where the galactic clusters come.” He admits that it would be “tempting” to regard the globular clusters as the source of the replacements, but this would challenge the physicists’ conclusions as to the source of the stellar energy and, of course, that is unthinkable.

There is no limitation on the process of capture from the environment which continually increases the size of a galaxy. So far as the capture process itself is concerned, the growth could continue indefinitely. However, the existence of an age limit also limits the galactic size. When this limit is reached the material phase of the great cycle of the universe of motion terminates.

TWENTY YEARS' PROGRESS

Principal Address to Second Annual NSA Conference

August 19, 1977

Oxford, Mississippi
by Dewey B. Larson
Portland, Oregon

The Reciprocal System of physical theory was first brought to the attention of the scientific community about twenty years ago in a book entitled *The Structure of the Physical Universe*, That book is now out of print, and for the last six or eight months I have been working on the first volume of a revised and greatly enlarged edition which, if all goes well, will be ready for publication in the not too distant future. One of the tasks that necessarily had to be undertaken in preparing for the revision was to make a detailed review of the entire subject matter of the original work, including the portions that were omitted for the published text in order to limit the size of the book. This review now offers a good opportunity to assess the amount of progress that has been made in the development of the theory during the twenty-year interval.

Many of those who come in contact with this system of theory are surprised to find us talking of ''progress" in connection with it. Some of these individuals evidently look upon the theory as a construction, something on the order of a building, or a work of art, which should be complete before it is offered for inspection. Others apparently believe that it originated as some kind of a revelation, and that all I had to do was to write it down. In either of these cases the concept of progress would, of course, be out of place. Before I undertake to discuss the progress that has been made, it is therefore appropriate to explain just what kind of a thing the theory actually is, and why progress is essential. Perhaps the best way of doing this will be to tell you something about how it originated.

I have always been very much interested in the theoretical aspect of scientific research, and quite early in life I developed a habit of spending mach of my spare time on theoretical investigations of one kind or another. Eventually I concluded that these efforts would be more likely to be productive if I directed most of them toward some specific goal, and I decided to undertake the task of devising a method whereby the magnitudes of certain physical properties could be calculated from the chemical composition. Many investigators had tackled this problem previously, but the most that had ever been accomplished was to devise some mathematical expressions whereby the effect of temperature and press are on these properties can be evaluated if certain arbitrary "constants" are assigned to each of the various substances. The goal of a purely theoretical derivation, one that requires no arbitrary assignment of numerical constants, has evaded all of these efforts. It may have been somewhat presumptuous on my part to select such an objective, but, after all, if anyone wants to try to accomplish something new, he must aim at something that others have not done. Furthermore, I did have one significant advantage over my predecessors, in that I was not a professional physicist or chemist. Most people would probably consider this a serious disadvantage, if not a definite disqualification. But those who have studied the

the subject in depth are agreed that revolutionary new discoveries in science seldom come from the professionals in the particular fields involved. They are almost always the work of individuals who might be considered amateurs, although they are more accurately described by Dr. James B. Conant as ''uncommitted investigators." The uncommitted investigator, says Dr. Conant, is one who does the investigation entirely on his own initiative, without any direction by or responsibility to anyone else, and free from any requirement that the work must produce results.

Research is, in some respects, like fishing. If you make your living as a fisherman, you must fish where you know that there are fish, even though you also know that those fish are only small ones. No one but the amateur can take the risk of going into completely unknown areas in search of a big prize. Similarly, the professional scientist cannot afford to spend twenty or thirty of the productive years of his life in pursuit of some goal that involves a break with the accepted thought of his profession. But we uncommitted investigators are primarily interested in the fishing, and while we like to make a catch, this is merely an extra dividend It is not something essential as it is for those who depend on the catch for their livelihood. We are the only ones who can afford to take the risks of fishing in unknown waters. As Dr. Conant puts it.

Few will deny that it is relatively easy in science to fill in the details of a new area, once the frontier has been crossed. The crucial event is turning the unexpected corner. This is not given to most of us to do...By definition the unexpected corner cannot be turned by any operation that is planned. .. If you want advances in the basic theories of physics and chemistry in the future comparable to those of the last two centuries, then it would seem essential that there continue to be people, in a position to turn unexpected corners. Such a man I have ventured to call the uncommitted investigator.

As might be expected, the task that I had undertaken was a long and difficult one, but after about twenty years I had arrived at some interesting mathematical expressions in several areas, one of the most intriguing of which was an expression for the inter-atomic distance in the solid state in terms of three variables clearly related to the properties portrayed by the periodic table of the elements. But a mathematical expression, however accurate it may be, has only a limited value in itself. Before we can make full use of the relationship that it expresses, we must know something as to its meaning. So my next objective was to find out why the mathematics took this particular form. I studied these expressions from all angles, analyzing the different terms. and investigating all of the hypotheses as to their origin that I could think of. This was a rather discouraging phase of the project, as for a long time I seemed to be merely spinning my wheels and getting nowhere. On several occasions I decided to abandon the entire project, but in each case, after several months of inactivity I thought of some other possibility that seemed worth investigating, and I returned to the task. Eventually it occurred to me that, when expressed in one particular form, the mathematical relation that I had formulated for the inter-atomic distance would have a simple and logical explanation if I merely assumed that there is a general reciprocal relation between space and time.

My first redaction to this thought was the same as that of a great many others. The idea of the reciprocal of space, I said to myself, is absurd. One might as well talk of the reciprocal of a paid of water, or the reciprocal of a fencepost. But on further consideration I could see that the idea is not so absurd after all. The only relation between space and time of which we have any actual knowledge is motion, and in motion space and time do have a reciprocal relation. If one airplane travels twice as fast as another, it makes no difference whether we say that it travels twice as far in the same time, or that it travels the same distance in half the time. This is not necessarily a general reciprocal relation, but the fact that it is <u>a</u> reciprocal relation gives the idea of a general relation a considerable degree of plausibility.

So I took the next step, and started considering what the consequences of a reciprocal relation of this nature might be. Much to my surprise, it was immediately obvious that such a relation leads directly to simple and logical answers to no less than a half dozen problems of long standing in widely separated physical fields. Those of you who have never had occasion to study the foundations of physical theory in depth probably do not realize what an extraordinary result this actually is. Every theory of present-day physical science has been formulated to apply specifically to some one physical field, and not a single one of these theories can provide answers to major questions in any other field. They may help to provide these answers, but in no case can any of them arrive at such an answer unassisted. Yet here in the reciprocal postulate we find a theory of the relation between space and time that leads directly, without any assistance from any other theoretical assumptions or from empirical facts, to simple and logical answers to many different problems in many different fields. This is something completely unprecedented A theory based on the reciprocal relation accomplishes on a wholesale scale what no theory can do at all.

To illustrate what I am talking about. let us consider the recession of the distant galaxies. As most of you know, astronomical observations indicate that the most distant galaxies are receding from the earth at speeds that approach the speed of light. No conventional physical theory can explain this recession. Indeed, even if you put all of the theories of conventional physics together, you still have no explanation of this phenomenon. In order to arrive at any such explanation the astronomers have to make some assumption, or assumptions, specifically applicable to the recession itself. The current favorite, the Big Bang theory, assumes a gigantic explosion at some hypothetical singular point in the past in which the entire contents of the universe were thrown out into space at their present high speeds. The rival Steady State theory assumes the continual creation of new matter, which in some unspecified way creates a pressure that pushes the galaxies apart at the speeds now observed. But the reciprocal postulate, an assumption that was made to account for the magnitudes of the inter-atomic distances in the solid state, gives us an explanation of the galactic recession without the necessity of making any assumptions about that recession or about the galaxies that are receding. It is not even necessary to arrive at any conclusions as to what a galaxy is. Obviously it must be something -- otherwise its existence could not be recognized -- and as long as it is something, the reciprocal relation tells us that it must be moving outward away from our location of light because the location, which it occupies is so moving. On the basis of this relation, the spatial separation between any two physical locations, the "elapsed distance," we may call it, is increasing at the same rate as the elapsed time.

Of course, any new answer to a major question that is provided by a new theory leaves some subsidiary questions that require further consideration, but the road to the resolution of these subsidiary issues is clear once the primary problem is overcome. The explanation of the recession, the reason why the most distant galaxies recede with the speed of light, leaves us with the question as to why the closer galaxies have lower recession speeds, but the answer to this question is obvious, since we know that gravitation exerts a retarding effect which is greater at the shorter distances.

Another example of the many major issues of long standing that are resolved almost automatically by the reciprocal postulate is the mechanism of the propagation of electromagnetic radiation. Here, again, no conventional physical theory is able to give us an explanation. As in the case of the galactic recession, it is necessary to make some assumption about the radiation itself before any kind of a theory can be formulated and in this instance conventional thinking has not even been able to produce an acceptable hypothesis. Newton's assumption of light corpuscles traveling in the manner of bullets from a gun, and the rival hypothesis of waves in a hypothetical ether, were both eventually rejected. There is a rather general impression that Einstein supplied an explanation, but Einstein himself makes no such claim. In one of his books he points out what a difficult problem this actually is, and he concludes with this statement:

Our only way out...seems to be to take for granted the fact that space has the physical property of transmitting electromagnetic waves, and not to bother too much about the meaning of this statement.

So, as matters now stand, conventional science has no explanation at all for this fundamental physical phenomenon. But here, too, the reciprocal postulate gives us a simple and logical explanation. It is, in fact, the same explanation that accounts for the recession of the distant galaxies. Here, again, there is no need to make any assumption about the photon itself. It is not even necessary to know what a photon is. As long as it is something, it is carried outward at the speed of light by the motion of the spatial location, which it occupies.

No more than a minimum amount of consideration was required in order to see that answers to a number of other physical problems of long standing similarly emerged easily and naturally on application of the reciprocal postulate. This was clearly something that had to be followed up. No investigator who arrived at this point could stop without going on to see just how far the consequences of the reciprocal relation would extend. The results of that further investigation constitute what we now know as the Reciprocal System of theory. As I have already said, it is not a construction, and not a revelation. Now you can see just what it is. It is nothing more nor less than the total of the consequences that result if there is a general reciprocal relation between space and time.

As matters now stand, the details of the new theoretical system, so far as they have been developed, can be found only in my publications and those of my associates, but the system of theory is not coextensive with what has thus far been written about it. In reality, it consists of any and all of the consequences that follow when we adopt the hypothesis of a general reciprocal relation between space and time. A general recognition of this point would go a long way toward meeting some of our communication problems. Certainly no one should have any objection to an investigation of the consequences of such a hypothesis. Indeed, anyone which is genuinely interested in the advancement of science, and who realizes the unprecedented scope of these consequences, can hardly avoid wanting to find out just how far actually extend. As a German reviewer expressed it

Only a careful investigation of all of the author‘s deliberations can show whether or not he is right. The official schools of natural philosophy should not shun this (considerable, to be sure) effort. After all, we are concerned here with questions of fundamental significance.

Yet, as all of you undoubtedly know, the scientific community, particularly that segment of the community that we are accustomed to call the Establishment, is very reluctant to permit general discussion of the theory in the journals and in scientific meetings. They are not contending that the conclusions we have reached are wrong; they are simply trying to ignore them, and hope that they eventually will go away. This is, of course, a thoroughly unscientific attitude, but since it exists we have to deal with it, and for this purpose it will be helpful to have some idea of the thinking that underlies the opposition. There are some individuals who simply do not want their thinking disturbed, and are not open to any kind of an argument. Williams James, in one of his books, reports a conversation that he had with a prominent scientist concerning what we now call ESP. This man, says James, contended that even if ESP is a reality, scientists should band together to keep that fact from becoming known, since the existence of any such thing would cause havoc in the fundamental thought of science. Some individuals no doubt feel the same way about the Reciprocal System, and so far as these persons are concerned there is not much that we can do. There is no argument that can counter an arbitrary refusal to consider what we have to offer.

In most cases, however, the opposition is based on a misunderstanding of our position. The issue between the supporters of rival scientific theories normally, is: Which is the better theory? The basic question involved is which theory agrees more closely with the observations and measurements and physical area to which the theories apply, but since al such theories are specifically constructed to fit the observations the decision usually has to rest to a large degree on preferences and prejudices of a philosophical or other nonscientific nature. Most of those who encounter the Reciprocal System for the first time take it for granted that we are simply raising another issue, or several issues, of the same kind. The astronomers, for instance are under the impression that we are contending that the outward progression of the natural reference system is a better explanation of the recession of the distant galaxies than the Big Bang. But this is not our contention at all. We have found that we need to postulate a general reciprocal relation between space and time in order to explain certain fundamental physical phenomena that cannot be explained by any conventional physical theory, but once we have postulated this relationship, it supplies simple and logical answers for the major problems that arise in all physical areas. Thus our contention is not that we have a better assortment of theories to replace the Big Bang and other specialized theories of limited scope, but that we have a general theory that applies to all physical fields. These theories of limited applicability are therefore totally unnecessary.

We are making some progress toward overcoming the obstacles that have stood in the way of getting an understanding of the real points at issue. This conference is itself one of the tangible indications of such progress. But this is not the kind of progress that I want to talk about today. During the last twenty years there has also been some substantial progress in the development of the theory itself; that is, in determining just what the consequences of the reciprocal relation actually are. As soon as it was evident that this relation provided the answers to many of the long-standing problems of physical science, what I naturally wanted to know was just how far its development would take us. Was it simply a physical principle of unusually wide applicability, but otherwise no different from many other basic principles of physics, or did the unprecedented range of applicability that was apparent at first glance indicate that here, at last, was the long sought key to the formulation of a general physical theory?

In order to find the answer to this question it was necessary to ascertain whether the reciprocal relation explained the basic phenomena of all of the major subdivisions of physical science, or whether its applicability was limited to those areas where its relevance was practically self-evident. This was no small task, and it took several years to reach the point where I was satisfied with the results Here you can see the advantage of being and uncommitted investigator. The "publish or perish" atmosphere of the modern university does not apply to those of us who are in this category. Nor are we subject to the usual pressure to produce some kind of results quickly in order to justify our financial support, since we do not set any such support, at least until after we arrive at some significant results. But even many years of work cannot carry an investigation of this kind into much detail, and as the time of the first publications, the status of the different parts of the project was very uneven in this respect. In the areas in which I had been working for ten or twenty years before discovering the reciprocal relation it was a relatively simple matter to express my earlier results in terms of the new theory, and in these areas the theoretical development was quite extensive -- one of the reasons, incidentally, why it was not feasible to publish all of my results in the original edition. In other areas, such as magnetism, for instance, I carried the investigation only far enough to make certain that the reciprocal relation would, in fact. apply to the general situation in each of those areas.

As matters stood, then, twenty years ago, it seemed that the principal task still to be accomplished was to develop the details of the theoretical structure in those fields where only the general principles had been established originally. At that time I had in mind that the next step toward publicizing the findings would be to publish the material omitted from the first book. I soon found, however, that most of those who came in contact with the theory were primarily interested in the fundamentals. Rather than wanting to know what practical results the theoretical development could produce, they wanted a more detailed and comprehensive explanation of the basic elements of the theory. During at least half of the intervening period, therefore, practically all of the time that I had available was spent on this phase of the project. In addition to the continued research and a large amount of correspondence, I wrote three books on different aspects of this subject matter.

One of the important results of the studies made during this period was a realization that in starting with the reciprocal relation we were not starting at the beginning. This relation is the cause of a great many things, to be sure, but on further examination it became clear that the relation itself is the result of something of a still more general nature. The really fundamental feature of the physical universe, we now find, is that it is a universe of motion: a universe in which the basic entities are units of motion. This finding can be classified as the most significant advance in theoretical understanding during the twenty-year period, although it is actually not new, as it is specified in the postulates. But its full significance was not recognized originally. At that time, the seven assumptions contained in the postulates were regarded as being on the same general level. It is now evident that this is not correct. The primary assertion contained in the postulates is that the physical universe is a universe of motion. The six other assumptions are of a subsidiary nature. In essence they are specifications as to the characteristics of the motion.

With the benefit of this understanding, the derivation of a number of the basic features of the universe becomes more direct and positive. The progression of space and time for instance, is now seen to be a direct result of the fact that, in the absence of physical action motion exists in independent units, each of which involves a unit of‘ space in association with a unit of time. The ratio of the two quantities is unity, and this space-time ratio, or speed, therefore constitutes the physical datum, the basic situation from which all physical activity extends. In other words, it is the natural reference system. Similarly it is now evident that the scalar nature of the progression of the natural reference system is a direct result of the fact basic units of motion have no property but magnitude. They have no vectorial direction. At the time of the first publication there was still enough uncertainty in this situation to make it advisable to state that it might be necessary to make the scalar nature of the basic motion the subject of an additional postulate. The new understanding of the basic situation has eliminated this uncertainty.

It is now also clear that the reason for the vibrational nature of the photon motion is more basic than originally believed. The original statement of the situation involved an interpretation of the reciprocal relation that is still valid, but is now seen to be superfluous, inasmuch as the reversals of the photon motion are required by more fundamental considerations. The basic point here is that, when we postulate a universe of motion, and then add to this postulate some assumptions as to the characteristics of that motion, the additional assumptions act as limitations on the motion. The assumption of‘ three dimensions, for example, excludes some kinds of motion that would be possible if the universe were four-dimensional or five-dimensional. The motions that can exist in the physical universe are therefore limited to those that are not excluded by the postulates. But when we specify the limitations to which the motions of the universe are subject, we are, in so doing, asserting that there are no other limitations. It follows that if a particular type of motion is not excluded by any of the assumptions contained in the two fundamental postulates. it is not excluded for any other reason. We can express this point in a form in which it has long been familiar to scientists and philosophers: Anything that can exist does exist.

The application of this principle to the photon takes this form: Inasmuch as the basic motion is continuous scalar motion at unit speed, no type of discontinuous motion scalar motion be derived from it directly. Furthermore, when the basic motion is viewed in the context of a fixed reference system, the outward motion of the natural reference system is always present. This means that the only kinds of motion that can exist at this level are (1) continuous outward motion, (2) continuous inward motion in opposition to the continuous outward motion, and (3) motion which changes continuously from outward to inward and vice versa; that is, simple harmonic motion. From the principle that what call exist does exist, we deduce that simple harmonic scalar motion exists, and since the characteristics of that theoretical motion with the observed characteristics of the photon, we can identify the theoretical motion with photon. Here, then, we have an explanation of the existence of the photon that comes directly from basic premises.

Even the reciprocal relation itself is now seen to be a direct consequence of the definition of speed, the magnitude of the motion. Thus, while the advances in understanding during the last twenty years have not led to any substantive changes in the basic elements of the theoretical system, they have accomplished a considerable amount of clarification and simplification of the fundamental structure. Recognition of the "universe of motion" concept as the basic feature of the theoretical system, rather than the reciprocal relation, has also resulted in a rather significant change of emphasis, in which the idea of "motion‘‘ has become more ‘ important. For example, in the original statement of the postulates, the simple scalar relation of space to time, as it exists in the basic units, was called space-time, following the general practice of conventional physics, although it was brought out specifically, particularly in the discussion of electrical phenomena, that any relation of space to time is actually motion. The subsequent findings have emphasized the desirability of placing more emphasis on the fact that the fundamental entities of the universe are units of motion, and the use of the expression "space-time" has therefore been discontinued. But the meaning of the postulates and other statements in which this expression was originally used is not altered in any respect by the change in terminology.

The new knowledge that has been gained with respect to the fundamentals has also emphasized the importance of the reference systems that we use in our observations of physical phenomena. It is now evident that we never see these phenomena system. The outward motion of the photons of radiation that we observe, for example, is not actually a physical process at all. Outward motion at unit speed is the condition that exists when no physical action is taking place: the reference datum from which all physical activity extends. But we do not view the universe in the context of this natural reference system, we see it in the context of an arbitrary system of reference that we have selected to fit for convenience, and in that context total absence of physical action appears as outward motion at unit speed. This outward motion actually has no direction, but by viewing it in the context of our arbitrary reference system we give it a direction that is determined by change. Photons emitted from a source of light, for example, move out in all directions from that source. Where only one source raises is involved, the situation is easily understood, but introduction of a second source raises some questions. For instance, the question as to why two photons emanating from different sources may collide, even though both are moving outward from all spatial locations was brought up at the conference in Minneapolis last year, and was discussed at considerable length.

In order to get a clear view of this situation it is necessary to recognize the special characteristics of scalar motion, which are given little attention in current scientific thought because motion of this kind plays only a very minor part in ordinary physical activity. As I have pointed out in my publications, the most familiar example of scalar motion in our everyday experience is the motion of spots on the surface of an expanding balloon. Such a balloon is usually considered to be existing in our normal three-dimensional spatial frame of reference, just like any other physical object. But if the motions of the spots are carefully considered to it will be seen that their motion cannot be represented in the spatial coordinate system unless some point or feature of the balloon is arbitrarily fixed with reference to the stationary reference system; that is, we most assign a reference point. The directions of the motions in the context of the reference system will depend upon the particular reference point that is selected.

In the case of the photons of radiation, the location of the emitting object is the point of reference As seen in the stationary reference system, the photons move outward in all directions from that location. No two photons emitted from this source can ever meet (unless diverted from their normal paths). If a second source of emission is now introduced, the photons emitted from this object will move outward in all directions from that source. If the second emitting object can be related to the first reference point that is, if it is moving outward from the first object at the speed of light -- then all photons emitted from the second object are moving outward from the first object, regardless of the direction in which they are emitted. All entities in this scalar system, emitting objects and photons alike, are moving outward from each other, just as all spots on the expanding balloon move outward from each other. No two of these entities can ever meet.

The point that many persons are apparently not taking into consideration is that if the second source of emission is not moving away from the first source have inward motions toward the first source, as well as their outward motions, and it the net motion is ward, either the sources or the photons which they emit may meet. Since inward moving objects of this kind are the only sources of emission that can be represented in a stationary reference system of finite size, it follows that the representation of the photons emitted from difference sources in an fixed reference system is possible only by relating these motions to different reference points. Each such reference point is the center of an expanding sphere of radiation, and the spheres overlap, so that the photons emitted from one object may meet photons emitted from any other.

This means, of course, that the change of position of a photon during a unit of time includes the change due to the relative motion of the source as well as the one unit of space traversed at unit speed. Some objections have been raised to this statement on the ground that it conflicts with the observed fact that the speed of light, is independent of the motion of the emitting object. However, the objectors are losing sight of the fact that the constant speed of light works both ways. Since the speed is independent of the relative change of position is, within certain limits, independent of the speed. The speed of the light that we receive from man object that is receding from us is identical with that of the light, which we received from an object that is stationary from our point of view. But the fact that the change in the spatial position of the emitting object does not affect the speed does not when are that the dealing with the speed of light our measurement of the speed does not give us any measure of the magnitude of the change in location.

In the meantime, while all of these efforts were being applied to working backward from the reciprocal relation to clarify the fundamental, work was also proceeding in the forward direction: that is, developing the consequences of the reciprocal relation (together with the other assumptions included in the postulates) in greater detail and into more of the subsidiary areas of physical science.

Because of the amount of time that has to be spent on items of the kind that I have already discussed, and on matters connected with the publication of the results, it has not been possible to undertake detailed studies in more than a few areas during this period, but since we are applying the same theory to all physical phenomena, every new result that we obtained in one area has some significance in other areas as well. A complete review of the situation in each of the fields that has been covered has therefore been necessary in order that the new edition may actually reflect the true status of the theoretical investigation. This review will be a time--consuming process, and it has not seemed advisable to postpone publication of the new edition for the additional year or two that will be required to complete it. The present plan is therefore to publish the work in two or three volumes. The first volume, which is now nearly ready, will include all of the fundamentals, both qualitative and quantitative, and the theoretical findings as to the nature and characteristics of the atoms and particles of matter. These subjects, which were covered in about 35 pages of the first edition, will be expanded to about 150 pages in the new volume. This will give you an idea of the extent to which the coverage of the various subjects will be enlarged.

Following the discussion of the material atoms and particles in this first portion of the new work, the findings with respect to these entities will be extended to the atoms and particles of the inverse kind, those of the cosmic system, and the observed phenomena in which they take part, the cosmic rays and the production of transient particles in the accelerators, will be examined in detail. This is one of the fields in which very substantial advances have been made, both theoretically, since the first edition was published. The general conclusions with respect to the structure and origin of the cosmic ray particles, the nature of the decay events, and the ultimate fate of these particles, as set forth in the rather brief treatment of this subject matter in the first edition, area still valid, but some modifications have been made in he details, and number of theoretical consequences not uncovered in the original investigation have been recognized.

This recognition has been come about mainly because some clues were provided by new experimental results. In principle, it should be possible to ascertain the facts in any area a by pure deduction from the theoretical premises, and number of the significant conclusions stated in the first edition were reached without the benefit of any assistance from empirical sources. For example, the existence of galactic explosions was asserted in the original texts, even though these phenomena were totally unknown at the time. The first evidence of such events was not discovered until several years later. But, in general, as long as so many area as remain to be investigated theoretically, it is not feasible to give any one area a the exhaustive considerations that would be required in order to bring to light additional phenomena that area a currently unknown. So far the present, until more investigators join in the efforts, it will be necessary to be content if the theoretical development keeps pace with experimental discovery. This is considerable more than conventional theory is able to do in these days of rapidly expanding experimental and observational horizons.

The original edition made only a brief mention of the production of transient particles in the accelerators, as this activity was just beginning at that time. A chapter devoted mainly to this subject therefore consists almost entirely of new matter. From a theoretical standpoint this particles production is simple a process in which the normal cosmic ray decay is forcibly reversed. The theoretical explanation of the sequence of step s in the production process therefore serves a double purpose in that it provides added confirmation of the validity of the theory of the ray decay.

The remainder of the first volume of the new edition will describe the principle properties of the solid state of matter other than the electrical properties, which will be taken up in a later volume, including the factors which govern chemical combination and molecular structure, inter-atomic-distance compressibility specific heat, and thermal expansion. With the exception of the inter atomic distance, which was given some consideration in the published text of the first edition all of this material is from the unpublished portion of that work, with whatever additions or modification are required to reflect the advances in the advance in theoretical understanding that have made during the twenty year period These advances area substantial, but they consists of a multitude of small items that do not themselves very well to treatment in the present general discussion.

Furthermore the advances in these area as have been mainly by product of work in other fields, rather than the result s of direct investigations.. The principal area a of direct theoretical study since the original publication, aside from the clarification of the fundamentals along the lines that I have already discussed, has been astronomical, particularly the very compact objects such as quasars, pulsars, x-ray emitters, etc., that have been the most spectacular discoveries in the astronomical field in recent years. There is a good reason for this concentration of astronomical phenomena. One of the things that has created some problems for us in cur efforts s to get a more widespread understanding of the Reciprocal System of theory is a rather general inability, or unwillingness, to recognize the logical status of the inverse phenomena envisioned by the theory There is much talk these days about "antimatter " and "antiworlds," but those who speak in such terms rarely visualize anything other than the same matter and the same world with some minor change, such as substituting positive charges for negative charges, or allowing time to rum backward. There is a general reluctance to accept the fact that there must be major differences, between the phenomena of our everyday experience and those of the anti, or inverse, sector of the universe. The nature of these major differences is quite obvious when the basic structure of the physical universe is clearly understood, but conventional physics has been unable to deal with the most basic phenomena, and the scientific community has tacitly agreed to ignore them. As expressed by Emilio Segré:

Although great progress has been made in atomic nuclear and particle physics in this century, some of the most fundamental questions in all these fields remain unanswered. Physics has, as it were bypassed them.

Essentially the same comments area made from time to time by other observers. For example, a report of the annual meeting of the American Physical Society in February 1969. published in the New Scientist, contains this statements:

A number of very distinguished physicists who spoke reminded us of longstanding mysteries, some of them problems so old that they area becoming forgotten, pockets of resistance left far behind the advancing frontier of physics.

In view of this general unconcern about the status of the basic elements of physical theory, it is is difficult for a purely theoretical derivation of the inverse relations to get much attention, and a conclusive empirical demonstration is likewise precluded as long as we area limited to the terrestrial environment that of light play only a very minor role here on earth. The concentrations of energy required for the production of such speeds area, however, present in some astronomical; objects, and an examination of the phenomena in which these objects participate provides us with confirmation of the theoretical conclusions that is not available at the low speeds of our ordinary experience.

The first edition included a general discussion of the principal features of astronomy and cosmology, as they appear in the light of the new theoretical findings.

No systematic efforts to extend the development of theory in this general astronomical field have been made in the intervening period, mainly because there is no audience to which the sufficiently familiar with the astronomical field to be able to appreciate the significance of these results, while the astronomers area not interested because even though their current theories area incomplete and in many instances actually contradictory, the existing situation is not urgent enough to induce them to give serious consideration to a system of theory that turns many of their current ideas upside down. For example, our new development shows that the stars which the astronomers regard as the youngest area actually the oldest, and vice versa. There area many items of observational evidence which show that the current ideas with respect to stellar ages area wrong, but the theorists have been able to devise explanations of the discrepancies which area, for the present, satisfactory enough to avoid any pressure for a change in thinking.

One conspicuous instance of this kind involves the relation between the ages of the stars and the age of the matter of which they area composed. Both conventional theory and the Reciprocal System agree that the heavy element content of matter increases with time, and that the concentration of heavy elements is therefore a qualitative indication of the age matter. But the observations show that the oldest matter in the universe, that in which the heavy element content is the greatest, is found mainly in which the astronomers regard as the youngest stars. The obvious conclusion is that the current ideas as to stellar ages area wrong. The theoretical development based on the astronomers have evaded the issues System arrives at the same conclusion, but the astronomers have evaded the issue by means of a very ingenious theory which postulates a series of processes that result in the formation of new stars from old matter. By utilizing such expedients the astronomical profession has been able to avoid the necessity of facing the question as to the validity of their present theoretical structure, and they area not receptive to any proposal for a major change.

In one astronomical area, however, the existing situation is quite different. Some of the recently discovery very compact objects have resisted all attempts at explanation on the basis of conventional ideas. If the quasars, for example, area as far away as their redshifts would indicate, on the currently favored “cosmological” basis them there is no process known to science that can account for the enormous amounts of energy that they must be generating, or for the observed speeds at which the components of some of these object area separating. On the other hand, if they area close enough to bring the energy and the observed speeds within the limits of current theory there is no known explanation for the redshifts. This is probably the most critical issue in astronomy today, but it is by no means the only problem that the new discoveries have raised. As a result, even though our new theory meets immediate opposition here. This is one place where it is widely believed, and freely asserted, that the existing basic ideas in physics area not capable of meeting the new demands upon them, and will have to be modified.

Here then, is an area in which the opposition to a new fundamental theory is at least somewhat disorganized. Further development of the details of the Reciprocal System of theory as it applied to these compact astronomical objects is therefore very desirable in order that we may present as strong a case as possible where the opposition is weak. Most of my research during the past ten years or so has therefore been concentrated in this area a. The results have been published in a book entitled Quasars and Pulsars and in some supplementary articles, the most recent of which was an article on Astronomical X-Ray Sources, which appeared in the March 1975 issue of Reciprocity.

According to those theoretical findings, the strange objects with which the astronomers are having so may problems are all entities in which motion is taking place at speeds in excess of that of light, and the astronomers‘ problems result from the fact that they neither recognize the existence of such speeds, or understand the nature of the results tat such speeds produce. At the time of publication of the first edition of The Structure of the Physical Universe the only known object of this class was the white dwarf star, and this differed from ordinary stars only in that it had what was, by our standards, a fantastically high density. In these modern days, when the theorists are accorded an almost unlimited license to make ad hoc assumptions to get around their difficulties, it is relatively easy to concoct some hypothesis that will explain a single discrepancy of this kind, and in this case it was postulated that the atomic structure “collapses” to produce the high density of the white dwarf.

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But later, when the same phenomenon, ultra-high density matter, was encountered in the quasars, the theory of a structural "collapse that was invented to explain the white dwarfs was obviously inapplicable. The theorists have therefore been working overtime, so far without success, trying to devise some different explanation to fit the quasars. A considerable amount of information is available about these objects, and this imposes some severe constraints on the theory constructors. In the case of the more recently discovered high-density objects, however, few facts showed up in the theorists have more latitude. When the same ultra-high density showed up in the pulsars, the neutron star hypothesis was invented. Then one more class of high-density objects, the x-ray emitters, appeared, and since none of the previous explanations can be applied to them, still another theory was necessary. By this time the theorists were scraping the bottom of the barrel, and they came up with a concept that outshines even the most imaginative products of the science fiction writers: the black hole. So in order to explain the different astronomical manifestations of one physical phenomenon, ultra-high density matter, there is an ever-growing multiplicity of separate theories, one for the white dwarfs, one for the pulsars, at least two for the x-ray emitters, and a whole assortment of what are still no more than conjectures for the quasars.

In the context of the Reciprocal System of theory, on the other hand, all of these very compact astronomical objects -- quasars, pulsars, observable white dwarfs, x-ray emitters, etc. -- originate in the same manner, as the results of explosions Their very high density is in all cases due to exactly the same cause: the introduction of additional time by reason of speeds in excess of unity, the speed of light. Because of the reciprocal relation between space and time the effect of the added time is equivalent to a reduction in the spatial volume occupied by an aggregate of matter.

The inverse phenomena resulting from the reciprocal relation between space and time play only a very small part in the physical activities of our ordinary experience, and the contribution of the basic relationships. This is an important task -- in fact, it is undoubtedly the most important task that confronts physical science today -- but it is one which is well in the background so far as most scientists are concerned, as their attention is centered on details rather than on basic principles. One exception, an area in which the inadequacy of the basic information is keenly felt, is particle physics. The situation in this field is described by V. F. Weisskopf in these words:

It is questionable whether our present understanding of high-energy phenomena is commensurate to the intellectual effort directed at their interpretation. The present theoretical activities are attempts to get something from almost nothing...We are exploring unknown modes of behavior of matter under completely novel conditions.

These comments are equally appropriate in application to the newly discovered astronomical objects, those that I have just been discussing. These two fields are therefore the ones in which the findings of the Reciprocal System have the most direct impact on the work of the scientific profession, and they are the fields in which we have the best opportunity to demonstrate the power and versatility of the new system of theory. They are not, in themselves, areas of spatial interest to everyone, but anyone who wants to known just how the Reciprocal System applies to his own field of work would be well advised to become reasonable familiar with them. There is no better way to gain a clear understanding of how the reciprocal relation applies to the phenomena of everyday experience than to see how it handles the sub-atomic particles, and the very compact astronomical objects: the phenomena that characterize the realms of the very small, the very large, and the very fast, where the effects of this reciprocal relation are greatly magnified.

THE FUNDAMENTALS OF SCIENCE IN THE TWENTY-FIRST CENTURY

by **Dewey B. Larson**

Principal Address to the Third Annual NSA Conference
University of Utah, Salt Lake City, August 18, 1978

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As you've noticed, it took quite a little while for the CBS crew to set up this evening, and on that account we're running at least a half an hour late. So I'm going to omit the first half hour of what I was going to say... It's unfortunate, because that will include some of my most shady jokes. But I'll try to take up from that half hour period. Frank took you back into history quite a little way, but just to do him one better, I'm going to go still farther back.

Five thousand years ago, when the invention of writing on clay tablets by the Sumerians first gave the human race an opportunity to leave a permanent record of its thoughts and actions, there was already in existence a rather sophisticated science of astronomy. The priests, who were the scientists of those days, were not only familiar with elementary astronomical facts, such as the apparent movements of the sun, moon and planets, but they had also advanced to the point where they were able to predict eclipses and to calculate the length of the year to within about a half hour of its present accepted value. The premises upon which these calculations and others of the same kind were made were the fundamentals of the science of that day, in the sense in which I am using the term now, that is, they were the most basic of the principles that were used by the science of that day.

These principles were originally derived by a simple application of what we now call inductive reasoning; that is, they were generalizations from experience. And that is the most reliable method of arriving at scientific principles, fundamental or otherwise, but unfortunately, it is limited by the amount of empirical information that's available, and by the extent to which that information has been analyzed. So the result is, that an inductive science, such as that of the ancient peoples, has a tendency to fall behind the progress of empirical discovery, and ultimately it acquires a rather embarrassing accumulation of unsolved problems. Now that was the situation in Egypt, in Babylonia and in the Far East about three thousand years ago.

The time was clearly ripe for some new approach, and that was provided by a remarkable group of thinkers who flourished in Greece during the Golden Age of that country's history. The source of order in the universe, these men said, was mind, and the proper way of arriving at general principles was to apply insight and reasoning. The result of that change in policy was to concentrate attention on the causes of physical phenomena rather than on the phenomena themselves. Where the Egyptians saw only the fact that a rock falls if it's released from a height, the

Greeks looked for the *cause* of the fall. Now they reasoned that everything must have its natural place, so the rock in falling is merely seeking its fixed natural place. In this way, by providing an explanation for what happened, they remedied the chief defect of the previous inductive theories. Similarly they reasoned, as professor Meyer indicated, that while the earth is obviously imperfect, the heavens are perfect. And all heavenly motions must then take the perfect form, that of a circle. So the orbits of the planets are undoubtedly circular.

Now observation and experiment were definitely relegated to a secondary position by the Greeks, but they were not disregarded altogether. So when the observations showed that the planetary orbits are not exactly circles, it was recognized that there was an awkward discrepancy that we have to do something about. But one of the strong points of an inventive science, such as that of the Greeks, is that it can easily accommodate new discoveries simply by *more* invention. Greek method of deriving scientific principles by pure invention is that it lends itself readily to the assimilation of new information by means of more invention: so they assumed that the planets move in small circles, called epicycles, and these epicycles them move around the main planetary orbit. Then, when further observational refinement disclosed still more discrepancies, those could be taken care of in exactly the same way, merely by adding more epicycles.

This Ptolemaic theory of planetary orbits is typical of inventive theories in general. And since we see it in a historical perspective, by taking a look at this Ptolemaic theory we can get an idea of the general characteristics of inventive theories. The first point that we need to note is that that theory was mathematically correct, within the existing observational limits, the then existing limits. That is a general characteristic of *all* inventive theories, because they're invented for that specific purpose. They're specifically designed to fit mathematics that are already known. The second significant point is that that theory, the Ptolemaic theory was conceptually wrong. The *interpretation* of the mathematics was wrong. That, again, is a general characteristic that applies to *all* invented characteristic of invented theories because of the circumstances under which they're invented. As many observers have pointed out, long-standing problems in science do not continue to exist because of a lack of competence on the part of those who are trying to solve them, nor do they continue to exist because of a lack of methods by which to go about solving them. They continue to exist because some piece or pieces of information that are essential, are missing. In the case of the Ptolemaic theory, there were two such pieces of information: the Greeks did not realize that the planets revolve around the sun rather than around the earth, and they did not know that there is a force of gravitation controlling those movements. Without those two pieces of information, neither the Ptolemaic theory, nor any other theory that was invented to explain the mathematics could have been correct. Now that is a general characteristic of inventive theories. And I am stressing it at this time, because it will be important later on in other connections. If the information is available, if all the essential information is there, then there's no need to invent a theory. Then we can obtain it by inductive means. If the essential information is *not* there, then any theory we invent cannot be conceptually right.

In view of the practically unlimited opportunities for making additional *ad hoc* assumptions to meet any situation that may arise, an inventive science never reaches the kind of a situation that causes the downfall of inductive sciences. At any given time there may be a few items for which plausible explanations have not yet been invented, but there is never the large accumulation of unexplained phenomena that characterizes an inductive science that has fallen behind the progress of empiricial investigation. However, the freedom to meet new requirements by adding more and more *ad hoc* assumptions, or epicycles, leads to a fate of a different kind. The time ultimately comes when such a system of theory simply has too many epicycles.

In the meantime, even though the fundamental theories in current use are inventive, the accumulation of empirical information and the construction of inductive generalizations of a lower rank continues. Ultimately, a point is reached where the principles derived inductively are sufficiently broad in their scope to challlenge the premises of the prevailing inventive theories. The Greek system reached this point about 500 years ago, and science then reverted to the inductive status, discarding inventive concepts such as the perfection of the heavens and the natural places of physical entities in favor of principles formulated by such men as Kepler and Newton through inductive reasoning from observed and measured facts.

With the benefit of all the empirical information accumulated during the approximately 2,500 years since the demise of the earlier inductive systems of the ancient civilizations, the new inductive science was a vastly improved product, and it scored some remarkable successes. At one time its practitioners were quite confident that a complete understanding of the universe was within their grasp. But here, again, the inherent inability of an inductive system of theory to keep pace with the progress of empirical discovery asserted itself. Eventually, Newtonian physics was confronted with a series of discrepancies for which it had no plausible answers. Another reversal of policy took place, and the inductive science of Newton and his contemporaries was replaced by a science based on invented principles, just as the first inductive sciences were replaced 3,000 years earlier by the inventive system of the Greeks.

When an idea or system of ideas gains general acceptance and becomes a familiar feature of current thought, its origins recede from view, and it is quite likely that many a reader may be reluctant to believe that the basic theories of modern physics—the relativity theory, for instance—belong in the same category as the Ptolemaic theory of astronomy. But all of them belong in the category of pure inventions. The originators of the modern theories do not deny this; indeed, they emphasize it. Einstein, for example, saw the general acceptance of his theories in just the way that I have described: a victory of inventive science over inductive science. In his opinion, pure invention is the only way in which true fundamental principles *can* be derived. Einstein was highly critical of Newton’s attempts to derive such principles inductively. He said this:

> Newton, the first creator of a comprehensive, workable system of theoretical physics, still believed that the basic concepts and laws of his system could be derived from experience.... the tremendous practical success of his doctrines may well have prevented him and the physicists of the eighteenth and nineteenth centuries from recognizing the fictitious characer of the foundations of his system.1

Einstein's own view was that the "basic concepts and laws of physics" (what I am calling the fundamentals) are "in a logical sense free inventions of the human mind."2 He elaborates this view in these statements taken from the book *The World As I See It:*

> Since, however, sense perception only gives information of this external world of "physical reality" indirectly, we can only grasp the latter by speculative means.
>
> The theoretical scientist is compelled in an increasing degree to be guided by purely mathematical, formal considerations in his search for a theory, because the physical experience of the experimentor cannot lift him into the regions of highest abstraction.
>
> The axiomatic basis of theoretical physics cannot be extracted from experience but must be freely invented..."3

There is a rather general tendency to assume that Einstein and the other architects of modern science were not actually as casual about the background of their theories as these words would indicate; that their basic principles must have been anchored to something solid at some point. But this is not true. As Rudolf Carnap puts it, these theories were "constructed floating in the air, so to speak."4 Einstein gives us enough information about some of his concepts to make it clear that when he talks about "free invention" he means exactly that. For example, the propagation of radiation plays a very important part in his theories, and his comments about the explanation that he invented to account for the mechanism of propagation and its relation to space are therefore very significant. In one of his books he tells us that the formulation of a theory to account for this phenomenon is a very difficult task, and he concludes with this statement:

> Our only way out seems to be to take for granted the fact that space has the physical property of transmitting electromagnetic waves, and not to bother too much about the meaning of this statement.5

The point of all this is that the invented theories of present-day science have exactly the same logical standing that the Ptolemaic theory of astronomy, the "natural place" theory of gravitation and the other theories invented by the Greek scientists had in their day. They are mathematically correct but conceptually wrong.

This statement may seem to be in direct conflict with the many confident assertions in scientific literature to the effect that the fundamental theories of modern physics are established beyond the shadow of a doubt. But if one examines the basis for these assertions, one finds that the evidence that is cited is purely mathematical. What has been established is that the theories produce the correct mathematical results. Like all other inventive theories, they have been specifically designed to produce these correct results. But none of them is unique. In each case there are alternatives that produce the same result. And, as Richard Feynman points out, there is no scientific criterion by which we can choose between any two of these alternatives ”because they both agree with experiment to the same extent. So two theories, although they may have deeply different ideas behind them, may be mathematically identical, and then there is no scientific way to distinguish them.” He goes on to say, ”Every theoretical physicist who is any good knows six or seven theoretical representations of exactly the same kind of physics.”6

What Feynman does *not* say is that these comments apply only to invented theories; they have no relevance to theories derived by induction from factual premises. The kinetic theory of gases, for instance, is an inductive theory. It explains gas laws in terms of the motions of the molecules of which the gases are composed. No one knows a half dozen other representations of these gas laws that are equally correct, or even one such alternative. Because it is tied in to experience—physically as well as mathematically—the kinetic theory is unique. It is *both* mathematically and conceptually correct. Inventive theories in general, including modern theories such as relativity and the quantum theories, are mathematically correct but conceptually wrong. This is not because of any errors in their construction, but by reason of their inherent nature.

Whether there is any net gain in using inventive theories during times when the scientific community would otherwise have no theories at all to account for some of the important observed phenomena is an interesting philosophical issue. Inventive theories are not actually necessary. The mathematics, which always antedate the theories, could be used equally well without any theoretical explanation. So the issue boils down to the question: Is a wrong explanation better than no explanation at all? There is a widespread tendency, dating back at least to Francis Bacon, to answer this question affirmatively, the argument being that a plausible explanation, even if wrong, will suggest some lines of further investigation that may be productive. On the other hand, it is easy to see that insistence on adhering to Aristotle’s inventive theories was a serious impediment to scientific progress, particularly in the latter years of the ascendancy of Greek science. It can logically be deduced that insistence on adhering to the modern inventive theories is having a similar effect today.

In any event, the fact that now needs to be recognized as we approach the twenty-first century is that we have once more arrived at the kind of situation that developed in the Middle Ages. The currently accepted fundamental physical theories derived by pure invention have come to be overloaded with epicycles, while coincidentally the development of inductively-based theory has caught up with the empirical discoveries, so that the way is now open for a return to the firmly-based inductive type of science.

The imminence of another policy reversal could easily be deduced from nothing more than a consideration of the times involved in the cycle of reversals just described. The first inductive sciences prospered for thousands of years before they were overthrown by the Greek inventive science. The first inventive science then endured for about 2,500 years before the second of the inductive sciences, the one commonly associated with the name of Newton, took over. The accelerating pace of science is evident in that only about four hundred years later this vastly improved inductive science was replaced by the second inventive science, the one now in vogue. Almost a hundred years more have elapsed. On the basis of a continuation of the same accelerating trend, it would be safe to predict, even without the benefit of any additional information, that another reversal of policy is now due. The fundamental principles of twenty-first century science probably will be those of a third inductive science—rather than the inventive concepts of twentieth-century physics.

But we do not have to depend entirely on inferences of this kind, as there is plenty of direct evidence leading to the same conclusion. The epicycles already have multiplied to the point of absurdity. The history of the quantum theories, for example, consists of a long series of modifications and conflicting interpretations which have made the theoretical structure practically unintelligible. Feynman, who should be in a position to assess the situation, tells us flatly, ”I think I can safely say that nobody understands quantum mechanics.”7

The situation with respect to atomic structure is similar. The most popular pastime in physics today is inventing properties by which the characterize quarks, the elusive particles of which the constituents of the atom supposedly are constructed. No one has ever seen, or otherwise observed, a quark, or anything that could be a quark. Indeed, one of the most urgent objectives of the theorists is to produce a plausible theory that will justify asserting that quarks are inherently unobservable. Nevertheless, we are told just what kinds of quarks can exist, and what their properties are: properties with such interesting names as color and charm.

In order to put this situation in the proper perspective, we should realize that while quarks have never been observed, the particles that are supposed to be constructed of quarks have never been observed either. Of course, these particles, the hypothetical constituents of atoms of matter, are called by familiar names, such as ”electron.” But as we saw earlier the properties that a particle must possess in order to play the part of the hypothetical electron in the atom are altogether different from those of the electron that is observed experimentally. There is actually no adequate justification for calling them by the same name. As Professor Herbert Dingle points out, we can deal with the electron as a constituent of the atom only if we ascribe to it ”properties not possessed by any imaginable objects at all.”8

This question of atomic structure provides a good example of the difference between induction and invention. Such men as Newton and Einstein recognized the difference very clearly. Newton emphasized that he did not employ invention *(”hypotheses non fingo*—I invent no hypotheses”), while Einstein condemned Newton’s inductive approach. But both procedures start in the same way—with a hypothesis—and this has confused the issue for many individuals. The difference lies in what happens when the hypothesis has been tested and found to be wrong. The Newtons then either discard the hypothesis, or modify it drastically. The Einsteins invent something that eliminates the discrepancy so that they can retain the orignal hypothesis.

When it was first discovered that atoms disintegrate under appropriate conditions, and emit particles in so doing, the hypothesis that the atom is constructed of such particles was very plausible. But, as we have seen, when this hypothesis is put to a test it fails, because the emitted particles are not capable of forming an atom. the inductive scientists, the Newtons, then have to abandon the hypothesis of an atom composed of particles, and try to formulate some other hypothesis. But the inventive scientists, the Einsteins, add some epicycles—they simply assume whatever is necessary to make the particles fit the requirements—and they retain the original hypothesis. This is the situation that exists today. Present-day theorists are obsessed with the idea that they must continue to subdivide matter until they come to an elementary unit. So they invent atomic constituents; they invent forces, such as the ”strong force” to hold these invented constituents together; they invent quarks from which to construct the invented constituents, and there is even a suggestion that it may be necessary to invent a sub-quark—the so-called superstrings of infinitesimal length and zero width. The particles of physics are rapidly approaching the status of the fleas in the popular little verse:

Big fleas have little fleas

Upon their backs to bite ’em.

The little fleas, still smaller fleas,

and so on, ad infinitum.

When we reach the point where further sub-division cannot be accomplished without invention, as is now the case with the atom, this tells us that the atom is *not* composed of smaller units of matter, but is composed of some other more fundamental entity. We will take up the question as to the identity of this entity shortly.

In the meantime, let us return to the question of inventive versus inductive science. While the position of the prevailing inventive science has been deteriorating, a large number of individual advances in different physical fields have extended a solid framework of inductive theory far beyond the level at which it stood in the early twentieth century. Scientific knowledge at that time was too limited to provide the necessary foundation for an inductive theory of the far-out regions into which observation was beginning to penetrate. This was the reason, of course, why inventive science gained the ascendancy. A few of the essential building blocks were already in place. The discrete nature of the units of radiant energy had been demonstrated, radioactivity had been discovered, electric current had been identified as a movement of electrons, and so on. But an immense amount of additional information had to be accumulated. That information is now available, and the final addition to the inductive structure needed to make it capable of dealing with the entire body of current empirical knowledge as it now stands has been provided by a new theoretical development. This development is the subject of my published works, and those of my associates11; its basic outlines will be presented in the next three chapters.

As often happens in scientific research, this theoretical advance was an unexpected result of a project atimed at a totally different objective. This project, begun a half century ago, attempted to devise a way of calculating physical properties, or at least some of them, from the chemical composition. In some respects this is a rather unfavorable subject for investigation—it has had a great deal of attention from previous investigators, and the most promising lines of approach have been rather thoroughly combed over. On the other hand, it is problem for which an answer certainly exists, since the physical properties of different substances obviously *are* results of their chemical composition.

I started with the concept embodied in the periodic table of the elements: the idea that the principal properties of these elements depend on the two variables represented vertically and horizontally in the tables. The first real advance that I made, after many false starts, was a recognition of the fact that one of these variables assumed both positive and negative values, whereas the other was always positive. Then, after much additional time and effort had been applied, it became evident that there were *three* of these principal variables rather than only two.

While these efforts to establish the *form* of the mathematical relations were under way, I was also struggling toward an understanding of the *meaning* of the mathematics. A tie-in to physical reality was necessary if the results were to be conceptually correct. Here, again, my first efforts followed conventional lines of thought.

The prevailing view was, and still is, that the differences between the properties of the chemical elements are due to variations in the number and arrangement of the sub-atomic particles of which these elements' atoms are assumed to be composed. My original course of procedure was directed toward accounting for the mathematical relations on this basis. Continued lack of success forced me to consider other alternatives. One of the possibilities that I eventually visualized was that some of the variability might be due to differences in the *motions* of the constituent particles rather than to differences in the atomic composition. This approach was likewise unsuccessful, but it did produce some indications that I was on the right track. These indications became stronger when I placed more emphasis on motions and less on composition. Eventually, the idea that *some* of the variability might be due to differences in the motions was discarded, and it was substituted by the idea that such differences are responsible for *all* of the variations.

This was the first really radical conceptual jump in the development of my thought, and it had some significant consequences. When the variability was ascribed entirely to differences in the motions, the existence of only three major variables made it quite clear that the motions must be motions of the atom rather than motions of many atomic constituents. Then, since inherent motion of the atom is almost certainly rotation, the number three naturally suggested rotations around the three perpendicular axes. The magnitudes of the three major variables could then be identified with the speeds of the three rotations. On this basis, the entity of which atoms of matter are composed, according to the conclusions reached earlier, is motion, and the atom is simply a combination of motions. The concept of an atom composed of subatomic particles now had to be discarded.

With this understanding of the general nature of the atomic structure, the stage was set for the final inductive step of the original project. Among the mathematical expressions that I had derived during the twenty years or more that I had already been working on the project were some interesting expressions relating certain physical properties of the elements directly to their atomic numbers. What I now had to do was to put these expressions in terms of motions. This was another long, and often frustrating, task. But after several more years in which I examined every possibility that I could think of, plausible or implausible, it finally dawned on me that one of the most intriguing of the mathematical expressions that I had formulated, one that related the inter-atomic distances of the elements in the solid state to their atomic numbers, could be very easily explained if there were a general reciprocal relation between space and time.

If anyone who encounters this idea for the first time finds it rather weird, I can understand their reaction. It struck me that way too. My first impression was that the idea of the reciprocal of space was conceptually absurd. But when I took a closer look at this concept, I could see that it was not so unreasonable after all. The only relation between space and time of which we have any definite knowledge is motion. And in motion, space and time *are* reciprocally related. So I examined further the consequences of such a relation. I found, much to my surprise, that it led directly to simple and logical solutions for at least a half dozen longstanding problems of physical science.

Anyone who has ever done research work will understand that this is the kind of a breakthrough that we visualize in our most rosy dreams, and, of course, it called for the initiation of a full-scale investigation to see just how far this clarification of the physical picture would extend. By the time of my first publication, in 1959, I had been able to formulate a set of postulates, incorporating the reciprocal concept. I could show that the principal features of the major subdivisions of physical science could be obtained by pure deduction from these postulates, without the aid of any supplementary assumptions or any information from experience. In the years since the initial publication, scientists in all parts of the world have joined in the effort. The scope of the deductive system has been increased to the point where we can predict that it will ultimately achieve the objective that Newtonian science once envisioned: It will encompass the entire physical universe.

For those who shudder at the thought of having to subject their scientific beliefs to a complete overhaul, I want to say that even though the new theoretical system rests on a different foundation, in most instances it arrives at the same conclusions as conventional theory. I would estimate that ninety percent of what now passes for scientific knowledge is incorporated into the new system either just as it stands, or with nothing more drastic than a change in the language in which it is expressed. Another five percent or so retains the mathematics in the existing form, but alters the interpretation. Not more than five percent of conventional scientific thought has to undergo any significant change, and these major reconstructions are confined to the far-out regions: the realms of the very small, the very large and the very fast, the same regions in which conventional science is encountering its most serious problems.

On first consideration, it may seem strange that totally different basic premises would lead to much the same results in so many cases. There is, however, a very simple explanation. The ninety percent of present-day science that is incorporated into the new deductive system without significant change is not derived from the general principles invented by Einstein and other modern physicists. It is derived empirically. The theories included in the ninety percent are the inductive theories of lower rank than the fundamental principles I have been discussing. What the new system of theory does in these areas is to provide a general theoretical basis for the empirically-derived relations, something that has never been available before.

As I pointed out in the discussion of the Ptolemaic theory, the construction of an inductive theory is impossible if some essential piece of information is missing. When observation and measurement were extended into what I have called the far-out regions, Newtonian science lost the battle to Einstein and his inventions because the essential piece of information that would have enabled understanding the situation in these far-out regions was not available. We have now identified it.

The piece of information that has been missing until now is the reciprocal relation between space and time. By applying this relation we have been able to construct a new inductive science on a specific and definite basis. Our problem now is to bring this development to the attention of the scientific community. Here we encounter the same obstacle that always faces innovators. Those who take a superficial look at the new development see only the fact that it challenges some popular ideas. They hold up their hands in horror and say: ”These people disagree with Einstein. They must be crazy.” I have yet to find any law of science that prohibits disagreeing with Einstein, but be that is it may, since this is such a common reaction, let us look at the situation and see just where this disagreement lies.

Einstein changed the course of science by developing his two theories of relativity—first the special theory, published in 1905, which applies only to uniform translational motion, and more than a decade later the general theory, which applies to accelerated motion. Peter Bergmann makes this comment about the relationship between the two:

> It is quite true that the general theory of relativity is not consistent with the special theory any more than the special theory is with Newton's mechanics—each of these theories discards, in a sense, the conceptual framework of its predecessor.12

So it is impossible to agree fully with both the general theory and the special theory. Actually, few front-rank scientists have much confidence in the general theory in spite of the lip service that is paid to it by the scientific community at large.

Bryce De Witt, one of the leading investigators in the gravitational field, which the general theory is supposed to cover, said categorically, "As a fundamental physical theory general relativity is a failure."13 P. W. Bridgman predicted that "arguments which have led up to the theory and the whole state of mind of most physicists with regard to it may some day become one of the puzzles of history."14 Thus, while we must concede that we disagree with the general theory on many counts, this is not much out of line with the most advanced scientific opinion.

Whether or not we disagree with the special theory, on the other hand, depends on just how this theory is defined. Bridgeman comments that there is a tendency to "define the content of the special theory of relativity as coextensive with the content of the Lorentz equations." P.K. Feyerabend, a prominent philosopher of science, puts it in this manner:

> It must be admitted, however, that Einstein's original interpretation of the special theory of relativity is hardly ever used by contemporary physicists. For them the theory of relativity consists of two elements: (1) the Lorentz transformations; and (2) mass-energy equivalence.15

On this basis, we do not disagree with the special theory at all. We are in full agreement with both the Lorentz equations and the mass-energy equivalence. The conclusions that so many physicists have reached in accepting the mathematical relations and rejecting Einstein's interpretations are the same conclusions that I have previously noted as applying to all inventive theories. Such theories are *all* mathematically correct and *all* conceptually wrong. Thus, if anyone actually examines the situation, instead of merely reacting emotionally, he will find that we disagree with Einstein's relativity *theories* only in the same way that general scientific opinion also disagrees with them.

But we do not accept all of the unsubstantiated *inferences* that are currently being drawn from these theories, because our new development enables us to distinguish valid from invalid inferences. The existence of speeds greater than that of light is an outstanding example.

Earlier we examined the case of a particle accelerated to a very high speed by a presumably constant electrical force: its acceleration decreases at a rate which will reduce it to zero at the speed of light. Since Newton's relation between force, mass and accelertion is merely a definition of force, the decrease in acceleration at high speeds must be due either to an increase in the mass or to a decrease in the force. There is no physical evidence to indicate which alternative is correct. Einstein simply *assumed* an increase in the mass. Our theoretical development now indicates that he made the wrong choice, and that the decrease in acceleration is actually due to a decrease in the effective force.

At the time Einstein made his choice there was nothing to indicate that it makes any real difference which of these alternatives is correct. Either one leads to some kind of a speed limitation. It is not likely, therefore, that Einstein gave the matter any extended consideration. But since our new development now indicates that speeds in excess of that of light definitely *do* exist, a review of the situation is obviously required. If Einstein's assumption of an increase in mass were correct, the limit at the speed of light would be absolute, as the mass would be infinite at that speed. But on the basis of our finding that what actually takes place is a decrease in the effective force, the limit is not on the speed, but on the capability of the process. All that the experiments actually show is that it is impossible to accelerate a physical object to a speed greater than that of light by electrical means, a conclusion that we also reach theoretically. But this does not preclude acceleration to higher speeds by other means, such as powerful explosions.

By accepting Einstein's denial of the existence of speeds greater than the speed of light as gospel that cannot be challenged, modern science has closed the door on the answers to some of the most significant problems of the present day. It is this mistake that has caused astronomy to become more fantastic than science fiction, with its neutron stars, black holes, white holes and all of the other extravagances. I have noted recently that quark stars have now joined this list. When the reciprocal relation between space and time is recognized, the need for all of this fictional science, as we may call it, is eliminated. The phenomena of the far-our astronomical regions can be explained on the same matter-of-fact basis that applies in our everyday world.

Science Without Apologies

In a well-known Gilbert and Sullivan opera a member of the constabulary undergoes some rather trying experiences in the course of carrying out his duties, and finally breaks into song, telling us that “a policeman‘s lot is not a happy one.” In many respects the lot of those who undertake to correct existing errors in any field of thought is similar to that of the policeman. There is no problem in the case of someone who simply makes a discovery in a new area. Both the scientific community and the world at large are ready to welcome a genuine addition to knowledge with some dearee of enthusiasm, and they are willing to look tolerantly on any speculation that is not specifically in conflict with established thought, even if it involves something that strains credulity to the utmost, a black hole, for example.

But long-standing problems in science, or in any other field, are sel dom, if ever, resolved by new discoveries, because their continued existence is almost always due to some errors in existing thought. any major, or basic, advance in understanding requires a sianificant modification of existing ideas, and this, like the policeman‘s efforts to enforce the law, is definitely unwelcome. Most individuals tend to regard an attack on one of their cherished ideas of long standing in the same way as an attack on one of their children, and they react just as emotionally. Obtaining a solution for a major problem is therefore not an end in itself; it is only the beginning of a long and difficult struggle. Many investigators are not willing to subject themselves to this kind of an ordeal, and their discoveries have to be made all over again years, or decades, or even centuries later.

In the classic case of Gregor Mendel, genetic science stood still for thirty yegrs until Mendel‘s findinas were rediscovered. J. J. Waterston developed the kinetic theory, but dropped it when his paper was rejected by the Royal Society as nonsense, and his work, too, had to be repeated years later and in another country. Max Planck, one of the giants of modern science, encountered the same kind of a reception. He was not so easily discouraged, and ultimately defeated his critics, but he was very bitter about the long battles that he had to fight to get recoanition of his findinas. He finally arrived at the conclusion, often quoted in the scientific literature, that new ideas never convince their opponents and have to wait until they die off and a new generation takes over.

No one knows how many valuable findinas have been lost because of the kind of a reception that they have encountered, since only the exceptional cases ever come to our attention, but they are no doubt very numerous, particularly in the non-scientific disciplines, where little proaress has been made toward gareement on criterig by which to distinguish between valid and invalid conclusions. It is rather sobering to reflect on the possibility that many of the problems that afflict modern society may have been solved long ago by investigators whose results have been ianored.

In any event, the point that I intend to emphasize is that in the new system of physical theory that I propose to discuss, the Reciprocal System of theory, as we call it, we have a science that requires no apologies. It is generally not realized that science has any need for apology as matters now stand. physical science is so far ahead of other fields of thought that it might seem as if we ought to be patting ourselves on the back, rather than apologizing. But we should realize that no other field of thought has had our advantages. No other has had the combination of a wealth of easily accessible data and three thousand years of systematic study of that data. Consequently, we cannot legitimately judge our present standing on the basis of what others have done. We will have to judge it on the basis of how well we have used the advantages that the others have lacked.

I do not intend to make such g judgement. But I do have to call attention to the way in which so many of the most prominent scientists of our time are going about apologizing right and left. For example, Richard Feynman finds it necessary to apologize for the basic weakness of present-day scientific thought: the lack of a theory of *general* application. He describes the situation in this way:

Today our theories of physics, the laws of physics, are a multitude of different parts and pieces that do not fit together very well. We do not have one structure from which all is deduced.l

This is an apology. Dr. Feynman realizes that after three thousand years we *should* have "one structure from which all is deduced." The apology is even more evident in the statement that follows the first one quoted:

Instead of having the ability to tell you what the law of physics is, I have to talk gbout the thinas that are common to the various laws; we do not understand the connection between them.2

A significant consequence of this lack of a general theory is an ingbility to grrive at an understanding of the most fundgmentgl scientific entities and phenomeng. In fact, a complete understanding of these fundgmentgl entities would be g general theory. Grgvitation is an outstanding example. accdrding to R. H. Dicke, "it may well be the most fundamental and least understood of the interactions."3 Dean E. Wooldrige gives us this assessment:

But what is gravity, really? What causes it? Where does it come from? How did it get started? The scientist has no answers . . . in a fundamental sense it is still as mysterious and inexplicable as it ever was, and it seems destined to remain so.4

This, too, is an apology: an apology for the inability of present-day science to account for what is conceded to be one of the most basic of all physical phenomena.

A very conspicuous weakness of current science is its inability to keep up with the observational and experimental proaress along the frontiers of science: the realms of the very small, the very large, and the very fast. One of these fields in which experimental knowledge is currently advancing at a rapid rate is the physics of high energies. V. F. Weisskopf makes this observation about the corresponding theoretical proaress:

It is questionable whether our present understanding of high-energy phenomena is commensurate to the intellectual effort , directed at their interpretation.5

Here again is an apology: an apology for the backwardness of theoretical understanding. Dr. Weisskopf is, in effect, telling us that we are not getting our money's worth out of the use that we are making of current physical theory.

The prevailing situation in astronomy is similar. Here the observers find themselves confronted with a whole range of newly discovered phenomena that they cannot understand on the basis of present-day physics. Martin Harwit describes the situation in these terms:

The fundamental nature of astrophysical discoveries being made — or remaining to be made — leaves little room for doubt but that a large part of current theory will have to be drastically revised over the next decades. Much of what is known today must be regarded as tentative and all parts of the field have to be viewed with healthy skepticism.6

Fred Hoyle, one of the most prominent astronomers of our day, has been even more critical. He speaks of the "total inadequacy" of current physical theory to meet the astronomical requirements.7 These statements by Harwit and Hoyle are worded as criticisms, but the individuals from whom they emanate are not only astronomers; they are also astrophysicists. In fact, Harwit specifically states that he is talking about astrophysics. Such criticisms of the current thinking of a profession by members of that profession are, in a very real sense, apologies.

Similar calls for a new kind of physics are now being heard from all directions. Ritchie Calder, f or instance, says that the energy problem in astronomy "cannot in any case be explained in terms of conventional physical theory."8 "Some new kind of physics seems to be needed," says an item in the British journal, the *New Scientist*.9 Simon Mitton tells us that "It is believed by some that the final solution will only come after astronomers have rewritten some of the laws of fundamental physics."10 I have a large collection of comments of this nature. As a general summary, the following statement by E. R. Harrison may be of interest:

It is not inconceivable that in the future our ideas on the nature of space, time and gravity on the cosmic scale will be entirely different from current ideas.11

The most sianificant result that will follow if, as we contend, the new physical theory that I am discussing here is a correct representation of the actual physical universe, the consequence that should cause everyone to hope that it is correct, is that the need for such apologies with respect to the fundamentals of science will be eliminated. Science will not need to apologize for the lack of a theory of general application, because the Reciprocal System *is* a general physical theory. Science will not need to apologize for a lack of understanding of the basic entities and phenomena of the universe, because the Reciprocal System provides such an understanding. Science will not need to apologize for the inability of its theoretical structure to keep up with the proaress of experiment and observation, because the Reciprocal System is not only abreast of empirical proaress, but well ahead of it in many areas.

It will, of course, be impossible for me to develop the structure of this theory in any substantial detail in the relatively short space that is available. Here I want to show just how the new theoretical development overcomes the difficulties that have led to the apologetic statements I have just quoted, and then take a look at some of the new answers that it supplies for old problems.

A areat many of the "multitude of different parts and pieces" of which conventional physical theory is composed are not derived from basic physical theory, but are products of inductive reasoning from factual premises. These portions of current physical thought, perhaps more than ninety percent of the total number of items, are not aff ected by any errors in the premises on which basic physical theory is founded. This is the reason why physical science has been so spectacular,ly successful in spite of the errors in its basic premises. It also explains why correction of these errors by the Reciprocal System makes so little change in the principles and relations applicable to the phenomena of everyday experience. Obviously the principles and relations that are not affected by errors in the basic premises of physical theory are not aff ected by correction of those errors either.

All of the "parts and pieces" of current theory that are derived from theoretical premises are based on the assumption that the universe in which we live is a universe of matter: one in which the fundamental entities are elementary units of matter existing in a framework provided by space and time. The eyes of the modern physicist are focused upon matter. As expressed by Arthur Beiser, "Broadly speaking, physics is the science of matter: its structure, properties, and behavior,"12 We now know, definitely and positively, that this view of the universe, which sees matter as the fundamental entity, is wrong, because we now know that there are processes whereby matter can be transformed into non-matter, and *vice versa*. Clearly, there *must* be some common denominator underlying both matter and non-matter. This is not a question of opinion or judgement. It is a definite requirement of the observed facts, and it is so recoanized by many of our most prominent scientists. Some of them have tried to identify the common denominator. Heisenberg, for instance, suggested that it might be energy:

The elementary particles are the fundamental forms that the substance energy must take in order to become matter, and these basic forms must in some way be determined by a fundamental law expressible in mathematical terms.13

However, Heisenberg admitted that he has no idea as to what that "some way" might be, and his hypothesis therefore had no practical value, other than as an expression of his recoanition of the lack of validity of the "matter" concept of the universe. All of the other possibilities that have been examined heretofore have been equally as unproductive as the energy hypothesis, so the physicists have closed their eyes to the error that they know exists in the fundamentals of their theories, and have continued to base these theories on a concept that they know is wrong. Here is the reason why, as Feynman pointed out in the statement previously quoted, present-day science has no general theory, no "one structure from which all is deduced." A valid general structure of theory cannot be erected on an unsound foundation.

One of the possible alternatives to energy as the common denominator of the universe that has been given consideration is motion. The fatal weakness of Heisenberg's energy hypothesis is that energy is purely scalar, and it therefore does not have the versatility that is necessary in order to produce the tremendous variety of forms in which physical entities exist. Motion, on the other hand, can be vectorial, and the introduction of direction provides the necessary range of possibilities. Many investigators, including such prominent scientists and philosophers as Descartes, Eddington, and Hobbes, have therefore tried to construct a theory of a universe of motion, but they have been no more successful than Heisenberg. The reason for the failure of all of these previous efforts was discovered in the course of the investigation that culminated in the development of the Reciprocal System of theory. These previous investigators failed to develop a workable theory because none of them actually postulated a genuine universe of motion. The universes that they envisioned were all hybrid products that retained the framework of the previous "matter" concept. Their "motion" simply replaced "matter" in the space-time framework. The unique feature of the Reciprocal System of theory is that it postulates a universe in which motion is the *sole* constituent: one in which there is *nothing but motion*.

The sianificant difference between this and all previous concepts of the nature of the universe is that it gives space and time an altogether different status. The definition of motion that is used in this theory — the standard scientific definition, we may say — is expressed by the *equation of motion*, which, in its simplest form, is $v=s/t$, where v is the speed or velocity, the measure of the motion, and s and t are space and time respectively. This equation, which defines motion in terms of space and time, is equally applicable in reverse; that is, it is also a definition of space and time in terms of motion. It tells us that in *motion* space and time are the two reciprocal aspects of that motion, and nothing else. In a universe of matter, the fact that space and time have no other sianificance in motion would not preclude them from having some other sianificance in some other connection, but in a universe composed *entirely* of motion, space and time cannot have any sianificance other than that which they have in motion. Thus, in a universe of motion, space and time are the two reciprocal aspects of motion, and they have no other sianificance. This *general* relationchip is the most important feature of a genuine universe of motion, the feature that is responsible for the distinctive characteristics of this universe. This is the reason why we have given the name "Reciprocal" to the system of theory that describes the universe of motion.

Recoanition of the true role of space and time brinas us directly to some general principles that explain many of those basic features of the universe that have been so troublesome to previous physical theory. One of these defines the condition of rest in the universe of motion, the datum level from which all physical activity extends. In a universe of matter, the most primitive condition that can exist is an empty universe: one in which the space-time framework exists, but no matter is present. Thus all physical activity in a universe of matter starts from zero. An empty universe of motion, one in which there is no motion, is impossible, because the universe of motion has no separate framework. If there is no motion, there is no universe. The most primitive condition in a universe of motion is one in which units of motion exist without interaction. Each of these units of motion consists of a unit of space in association with a unit of time; that is, the speed is unity. Consequently, the condition of rest in a universe of motion, the datum from which all action extends, is not zero speed, but unit speed.

What this means in practice is that if an object without independent motion exists at a spatial location x at time t, then at time t + 1 it will exist at spatial location x + l. The advance of one unit of time has been accompanied by a similar advance of one unit in space. Thus the spatial reference system of the physical universe is not a stationary system, as seen in current thought, but a moving system, in which all locations are moving outward from all other locations at a constant unit speed, a speed that can easily be identified as the speed of light. An analogy that is helpful in this connection is the motion of spots on the surface of an expanding balloon. (An expanding three-dimensional object would be a closer analogy, but the balloon is more familiar.) Like a spot on the expanding balloon, any object which has no capability of independent motion does not remain stationary with respect to its neighbors. It remains stationary in the natural reference system, the system to which a universe of motion actually conforms, and it therefore moves away from those neighboring objects at the speed of light.

Here, then, we have one of the basic features of a universe of motion: a moving spatial system of reference. Let us see what this aspect of the theoretical universe can do for us. One of the important physical phenomena for which physical science has no explanation is the propagation of light and other electromaanetic radiation. A number of hypotheses have been advanced, but they have all fallen by the wayside. Newton's hypothesis of particles shot out from the source in the manner of bullets from a gun, and the rival hypothesis of waves in a hypothetical ether were both ultimately rejected because they failed to stand up under close scrutiny. There is a widespread impression that Einstein solved this problem, but Einstein himself makes no such claim. In one of his books he goes on at considerable lenath about how difficult a problem this actually is, and he concludes with this statement:

Our only way out seems to be to take for granted the fact that space has the physical property of transmitting electromaanetic waves, and not to bother too much about the meaning of this statement.14

This conclusion that there is no way out of the difficulty but to assume an answer and take its validity for granted is simply another kind of an apology. One of the reasons why those who are in any way connected with science ought to hope that the Reciprocal System is a correct account of the physical universe is that it solves such problems rather than sweeping them under the rug as Einstein has done with the radiation problem. The photon of radiation is an object that has no capability of independent motion; no mechanism whereby it can alter its position. In a universe of motion it therefore stays put in its original location, and is carried outward at the speed of light by the motion, or proaression, of the natural reference system. This is all there is to it. We do not have to dream up any complicated mechanism, or make a guess and "take it for granted."

But this is not the whole story. One of the most sianificant features of a *general* physical theory is that the *same* principles apply in all physical fields. We do not have to develop new laws and new principles in every new field that we enter. The same general principle that applies to the motion of the photons of radiation — the proaression of the natural reference system that causes them to mave outward at the speed of light — applies with equal force to all other objects in a universe of motion. All physical objects move outward at the speed of light. However, this is not necessarily the only motion of such objects, as it is in the case of the photons. Most other objects are subject to additional motions, and the actual change of position in a stationary reference system is the net resultant of all of the motions of an object.

The most important of these other motions is gravitation, which moves all material objects inward toward each other, thus acting in opposition to the outward motion of the natural reference system. In our local environment the inward motion due to gravitation is so much areater than the outward motion that the outward motion is negligible, and gravitation appears to be the only general motion of material objects. But gravitation is attenuated by distance, and at some distant location the gravitational effect of any material agaregate is reduced to equality with the constant outward motion. According to the theory, beyond this point the net motion is outward, increasing toward the speed of light at the extreme distances. On this basis, therefore, all agaregates at extreme distances, where the effect of gravitation has been reduced to a negligible level, should theoretically be receding at the full speed of Iight in the same manner as the photons of radiation.

Astronomical observations indicate that this is just what is happening in the case of the distant galaxies. All agaregates of matter other than the very largest, the galaxies, are under some dearee of gravitational control by larger agaregates, and their outward motion is limited, but the galaxies behave in exactly the manner required by the theory. The nearby galaxies have very little motion one way or the other, but all of the very distant ones are found to be moving radially outward at very high speeds, increasing with the distance, and reaching a substanti.al fraction of the speed of light at the present observational limit.

Current astronomical thought attributes the high recession speeds to a gigantic explosion at some singular point in the past history of the universe, which threw all of the contents of the universe out into space at the enormous speeds now observed. In spite of its purely *ad hoc* and rather fantastic character, this Big Bang theory has gained widespread support, mainly because there has heretofore been no more satisfactory alternative. But its lack of validity is easily demonstrated if we examine the motions of some of the smaller agaregates, because we find that these, too, have outward motion components: motions that are impossible to explain on the basis of the Big Bang hypothesis.

The globular star clusters provide a good example. These are immense, nearly spherical, agaregates containing anywhere from a hundred thousand to more than a million stars, separated by enormous distances, not much less, on the average, than those between the stars in the solar neighborhood, distances measured in light-years. The structure of these clusters has long been a puzzle to astronomers. As expressed by E. Finlay-Freundlich in a publication of the Royal Astronomical Society, “The main problem presented by the globular star clusters is their very existence as finite systems.”15 As this author brinas out, some force must oppose gravitation in order to account for the observed structure, but no force adequate for the purpose has ever been identified. The only possibilities that have ever been suggested are rotation or high speed motions and frequent collisions as in a gas agaregate. But there is no evidence of any such motions on a scale adequate to counterbalance gravitation. On the basis of what is currently known, therefore, the cluster shoul d either collapse into one central mass or disperse. It does neither. All of the astronomical evidence indicates that these clusters are stable long-lived objects

. What has not been recoanized is that the problem with respect to the globular clusters is the *same* problem that exists with respect to the galaxies. If gravitation is the only force to which the galaxies are subject, they, too, should collapse into one central mass. As Einstein expressed it, “The stellar universe ought to be a finite island in the infinite ocean of space.”16 The observed situation calls for some kind of an antagonist to gravitation, and the Big Bang has been invented for this purpose. However, the similarity of the galactic situation and that of the globular clusters makes it almost a foregone conclusion that the same antagonist is involved in both cases. The Big Bang is therefore ruled out, as it obviously cannot explain the globular cluster structure, not even if it is supplemented with a host of Little Banas. But the outward proaression of the natural system does supply just what is needed. Each star of the cluster is outside the gravitational limits of its neighbors, and it therefore moves away from them in the same manner in which the distant galaxies recede from each other. But the outward motion of the cluster stars is limited by the gravitational eff ect of the cluster as a whole, and the net result is that each star takes up an equilibrium position in a stable structure.

So far I have discussed three important physical problems that are resolved by this one principle that comes directly out of the basic postulate of the Reciprocal System. This is by no means the full extent of the applicability of that principle. In fact, the outward proaression of the natural reference system plays a sianificant part in every physical field. However, this discussion will have to be limited to fundamentals, so I will return to the basic concept and point out another of its direct consequences.

This second unique feature of the universe of motion is that the fundamental motion is scalar. The unit of motion is simply a maanitude: one unit of space per unit of time. Scalar motion is given very little consideration in conventional physics because it plays very little part in the phenomena with which present-day science deals. The motion of the spots on the surface of the expanding balloon that I used earlier for purposes of analogy is scalar, but physicists are not much interested in expanding balloons. The finding that the basic motion of the universe is scalar changes this situation drastically. The properties of scalar motion now become extremely important.

Scalar motion, like other scalar maanitudes, may be either positive or negative. A positive scalar motion, an increasing maanitude, appears in a fixed spatial reference system as an outward motion. A negative scalar motion, a decreasing maanitude,.appears as an inward motion. I am often told that attributing a direction such as inward or outward to a scalar quantity is contradictory, since a scalar quantity, by definition, has no direction. But we do not deal with the·scalar quantity itself; we deal with the representation of that quantity in a fixed spatial reference system, and tha.t representation is necessarily directional. In fact, it has two directions: a scalar direction — inward or outward — and a vectorial direction, such as northeast or southwest. These directions are independent of each other. A photon moving east from a source is moving outward. A photon moving west from the same source is likewise moving outward.

One of the sianificant consequences of this independence of the directions is that a motion may have a continually changing vectorial direction — that is, it may be a rotation — while it still retains the same inward or outward scalar direction. For reasons which are explained in my book *Nothing But Motion*, scalar rotation can take place only in the inward direction. Where a complex motion has several rotational components, one or more of the minor components may have the outward direction, but the net total rotation must be inward. A rotating scalar unit is therefore moving inward in the manner of a spot on the surface of a contractinag balloon. In a spatial reference system, this scalar rotation resembles a rolling motion.

In a universe composed entirely of motion, all existing entities and phenomena are either motions, combinations of motions, or relations between motions. It follows that in order to arrive at a full description of a universe of motion all that is necessary is to determine what kind of motions and combinations of motions are theoretically possible, and what changes can take place in them. In total this is a stupendous task because of the vast amount of detail into which the development must be carried, but this detail is at a minimum in the early stages of the development. The structure of the Reciprocal System of theory is therefore simple, clear and distinct in the very areas in which conventional theory is having serious difficulties; that is, in the physical fundamentals. The correlation between the basic theoretical motions and the basic physical phenomena is clear from the start. The two basic physical phenomena, as we observe them, are radiation and matter. The two basic kinds of combinations of scalar motions are vibration and rotation. It then follows that the basic unit of radiation is a scalar vibrating unit, and the basic unit of matter is a scalar rotating unit.

As I have just brought out, scalar rotation is a continuous inward motion: a rolling motion in the inward direction. We cannot identify inward motion in space as such, but objects moving inward are moving toward each other just as they would if each exerted an attractive force on the others. This inward motion of the rotating units that constitute the fundamental units of matter is, of course gravitation. Here, again, we have a simple answer to a long-standing, and seemingly difficult, problem. The units of matter gravitate — that is, they move inward toward each other — because that is what they are. The basic units of matter are units of inward rolling motion.

Furthermore, this answer to the question as to what gravitation *is* provides an equally simple explanation of its properties, which have been extremely difficult to understand on the basis of previous theories. Conventional theory regards gravitation as a force exerted by each mass on all others. But that hypothetical force is something totally different from any other force of which we have any knowledge. So far as we can tell from observation, it acts instantaneously, without an intervening medium, and in such a way that it cannot be screened off or modified in any way. These characteristics have been so difficult to understand that present-day theorists have taken the unprecedented step of repudiating the physical evidence, and contending that regardless of the observed facts, gravitation *must* be propagated at a finite speed through a medium or something with the properties of a medium. I have been talking about apologies, but this is more than an apology; it is an outright defiance of the observed facts.

Like the answers to the problems that I mentioned earlier, the explanation that the Reciprocal System provides for the peculiar properties of gravitation is very simple. Gravitation does not act like a force because it is not a force. The effect of the gravitational motion in bringing agaregates of matter closer together is the same as that which would result from a force of attraction, if such a force existed. For purposes of calculation we may therefore treat gravitation as a force. But this does not give it the properties of a force. Its properties are determined by its true nature. Since each agaregate is moving independently, the results of that motion are effective instantaneously. There is no propagation, and consequently no need for a medium. Likewise, the independent motions are not affected by anything that exists, or takes place, between the agaregates.

The brief glimpse of the Reciprocal System of theory that I have given here might be described as a qualitative view of the physical fundamentals. A complete theory of the universe must also deal with the quantitative aspects. Indeed, the areater part of the development of the details of the theory is concerned with these quantitative aspects. I therefore want to give also a little idea as to how the quantitative side of the theory develops.

The identification of the basic unit of matter is an appropriate example. In this discussion I have ref erred to the basic unit of radiation by its usual name, the photon, but I have left the identity of the basic unit of matter undefined. The reason is that this entity is not immediately obvious, as it is in the case of the photon. The available qualitative information tells us that the unit of matter is a rotating scalar motion, but it does not tell us whether that rotating unit is an atom, a sub-atomic particle, a quark, some kind of a sub-quark, or an entirely diff erent entity. In fact, it does not tell us whether there is *one* basic unit from which all matter is composed, or whether there are many different kinds of basic units of matter that can be formed directly from the underlying scalar motion. We can, however, develop the quantitative characteristics of the rotating unit, or units, and these will enable us to identify the corresponding physical structures.

All of the fundamental scalar units of motion are alike, so all that we have to begin with is the series of cardinal numbers; that is, a combination can contain one unit, two units, or n units, of scalar rotational motion. At first glance it would seem impossible to build this series of numbers up to the are at variety of physical phenomena that we observe in the universe, but we have postulated a three-dimensional universe, and as soon as we begin looking at these numbers in terms of the geometry of three dimensions, the possible variations proliferate enormously. If there is only one effective scalar unit in the rotating combination, the rotation is necessarily one-dimensional. If there are two units, the rotation can be two-dimensional. For reasons which are explained in my book *Nothing But Motion*, three-dimensional rotation is not possible, but if the rotational combination includes three scalar units there can be both a one-dimensional and a two-dimensional rotation. We further find that geometrical considerations permit two of these three-unit combinations to rotate around the same central point, producing a double structure. This is the most complex structure that geometry will permit, and further additions of scalar motion go toward increasing the rotational speeds.

Here, then, we have the answer to the question as to whether there is one basic unit of matter analogous to the unit of radiation, the photon. Because an individual unit of matter can rotate in one or all of the three available dimensions, there are different kinds of rotating structures, in some of which the rotating speeds are variable. Thus there are many different basic units of matter, rather than just one "building block." There are, however, limits to the total amount of rotation that can be incorporated into any one rotating unit. Speed is added to the double units in increments equivalent to the original unit of this kind. When the total reaches 118 such units, the rotational structure disintegrates. Thus there are 117 kinds of the double units. Similar restrictions to which the simpler units with only one rotating system are subject limit the number of such combinations to seven. Then, because of the general relation between space and time, all of these units are duplicated with space and time interchanged. Thus there are 117 reciprocal double units and seven reciprocal single units.

Identification of the inverse units is facilitated by recoanition of the fact that the properties of the units are also inverse. For example, if one of the normal double units has mass m, the reciprocal unit has mass 1/m. For reasons which are not quite so obvious, the life of these inverse or reciprocal units is very short in an environment in which the normal units predominate. With the benefits of this information, we are now able to identify the different basic forms of matter, all of which are rotating combinations of motions. The 117 double units of the normal type are the atoms of the chemical elements. The seven single units are the sub-atomic particles. The 117 inverse double units are the transient particles known by such names as mesons. The seven inverse single units are what are known as antiparticles.

Of course, these conclusions are in direct conflict with current ideas as to the structure of atoms of matter. But it should be realized that all justification for the concept of an atom composed of smaller particles of matter was eliminated by the discovery that matter can be transformed into non-matter, and *vice versa*. This observed fact shows conclusively, as Heisenberg and others have recoanized, that the simplest unit of matter is composed of some other entity, an entity we have now identified as motion. It then follows that there is no longer any justification for *inventing* particles of matter from which to construct an atom, or what amounts to the same thing, inventing hypothetical properties for existing particles to enable them to meet the requirements. Since there are no observable units of matter from which atoms can be constructed without giving them a new ad hoc set of properties, the logical conclusion from the empirical evidence is the same as that which we derive from the Reciprocal System of theory; that is, the atoms, the sub-atomic particles, and the transient particles are all basic units of matter, composed not of smaller particles of matter, but of units of motion.

The scope of a general theory of the physical universe is so immense that it is not possible to cover more than a very small portion of the whole in a short overview such as this; but I have shown how the Reciprocal System of theory overcomes two of the shortcominas of conventional physical science for which apologies are currently being made. The Reciprocal System is a general physical theory, and it does provide simple and logical explanations for the basic physical phenomena that have heretofore been so difficult to understand.

SCALAR MOTION

by **Dewey B. Larson**

Principal Address to the Sixth Annual NSA Convention
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Whenever a new physical theory appears, one of the first objectives of the supporters of that theory is to find a crucial experiment, an experiment whose results agree with the new theory, but are definitely in conflict with its predecessors. This is a difficult undertaking, not only because it is hard to find an experiment of the right kind, but also because the results of that experiment, if an experiment *is* found, can usually be accomodated to existing theory by *ad hoc* assumptions of one kind or another. And the scientific community prefers to accept a modified theory of that kind, in preference to an entirely new theory, even if the modifications require such wild ideas as black holes or charmed quarks. Nevertheless, a crucial experiment occasionally does make its appearance.

Perhaps the most famous was the Michelson-Morley experiment. The constant speed of light disclosed by that experiment was devastating to the Newtonian system, and created a conceptual vacuum that cleared the way for the acceptance of Einstein's relativity theories. My associates and I have naturally been on a lookout for a crucial experiment of this kind, and many leads have been followed up. Dr. Huck has an electrical experiment underway. Dr. Cramer has been working with a project that involves measuring the positions of the moon, and many other ideas are in various stages of development.

Last year at Huntsville I gave a preliminary report on what will be my contribution to this project. I was not able to devise a crucial experiment, but what occurred to me was that we could reach exactly the same point by identifying some previously unrecognized result of some *earlier* experiment. After all, we are not interested in the crucial experiment itself. What we want is the crucial piece of information that is derived from that experiment, and it actually makes no difference whether we get that from a new experiment or an old one. The public library in my home city is currently featuring a sign that says, "A book is always new if you have never read it." The same is true of physical facts. A physical fact is always new if it has never before been recognized.

In the course of my investigations over the past forty or fifty years I have uncovered a great many hitherto unrecognized or disregarded physical facts—a surprisingly large number of them. But the one that fits our present requirements is a hitherto unrecognized property of scalar motion. Scalar motion itself is well known, although not by that name. For example, when the recession of the distant galaxies was first discovered some years ago, the astronomers needed an analogy to help explain the nature of that motion, and they knew right where to look for it.

Almost every such explanation reads something like this one, which was taken from a current astronomical text: The common analogy likens the galaxies to spots on the surface of a balloon that is being inflated. As the rubber stretches, all the spots move away from each other. The widespread use of this analogy testifies to the general understanding that the motion of the spots on the expanding balloon and the motion of the distant galaxies is, in some way, different from ordinary motion; but the importance of that motion is not seen to be sufficient to justify any systematic exploration of its properties. After all, nobody is very much worried about the physics of expanding balloons. But that situation was changed very drastically by the development of the theory of the universe of motion, because scalar motion plays a very important part in that theoretical structure. So it was necessary for me to undertake the full-scale investigation of scalar motion that had not hitherto been attempted.

If we examine the motion of the spots on an expanding balloon in isolation, without placing the balloon in a reference system, or introducing a reference system into the balloon, or if we construct a similar mental picture of the recession of the distant galaxies, there is no way by which we can distinguish the motion of any one spot or of any one galaxy from the motion of any other. Each spot and each galaxy is simply moving outward away from all others at a constant rate of speed. That motion has only one property—a scalar magnitude. Such a motion is, by definition, scalar. The scalar motions readily accessible to observation are not isolated in the manner of those I have mentioned, but are connected to a physical reference system in some manner, as for instance by placing the balloon on the floor of a room. That physical coupling to the reference system provides the directions that the motions themselves do not *not* have. If the coupling is fixed, so that the directions are likewise fixed, then the combination of a scalar motion and a coupling to the reference system behaves in most respects in the same way as an ordinary vectorial motion, and it is not currently distinguished from a vectorial motion.

Here is a place where a very important point has been overlooked. It is recognized that the balloon can be placed anywhere in the room, and it follows that the motion of any particular spot can take any direction in the reference system. But what has not been recognized, or at least not clearly recognized, is that the ability to take any direction is not limited to a constant direction. For example, the balloon may be rotated. The effect of a continuous rotation of the coupling to the reference system is to distribute the scalar motion over all directions in the dimension or dimensions of rotation, thus producing a *distributed scalar motion.* The properties of that distributed scalar motion are quite different from the properties of combined vectorial motions in different directions. In vectorial motion the magnitude and the direction are interrelated. For example, if a vectorial motion of magnitude X in a specific direction is superimposed on a vectorial motion of equal magnitude in the opposite direction, the resultant is zero. Similarly, vectorial motions of equal magnitude in all directions add up to no motion at all. But the magnitude of a distributed scalar motion is not altered by the changes in direction.

The balloon example is a relatively unimportant motion, originated and maintained by human action. But the fact that such motions exist means that the same kind of motions may originate from natural causes. So we thus arrive at the conclusion that there probably exist somewhere in the physical universe a class of distributed scalar motions that are not currently recognized as motions.

As soon as we reach that conclusion, it is almost immediately apparent that the reason for the lack of recognition is the prevailing attitude toward the concept of force. Force is defined for scientific purposes as the product of mass and acceleration. Motion itself is measured, on an individual mass-unit basis, as speed or velocity. That is, each individual mass-unit moves at that rate. On a collective basis, it is measured as the product of mass and velocity, which is currently called momentum, but in earlier days was known by the more descriptive name of quantity of motion. The time rate of change of the motion is an acceleration on the individual mass-unit basis, and the product of mass and acceleration, or force, on the collective basis. This obviously means that force is specifically defined as *a property* of motion; and it follows that force cannot be autonomous in the manner in which the so-called fundamental forces of nature are currently regarded. Every fundamental force is a property of a fundamental motion. But that creates problems for present-day science. For example, the electric charge produces an electrical force, and so far as we can tell it produces that force directly, with no sign of any intervening motion of the kind that is required by the definition of motion. Present day science handles that problem very simply—by ignoring it. But if we want to actually resolve the problem, what we need to do is to identify the electric charge as a distributed scalar motion. The charge itself is the motion, so we don't need that intervening motion that we don't find.

This process of identification is a necessary part of all scientific work, because the entities with which we deal don't come equipped with labels. The process itself is simple enough. It operates on what is sometimes called the 'duck principle.' You are familiar with that, I presume? If it looks like a duck, and it swims like a duck, and it waddles like a duck, and it quacks like a duck, then it's a duck. We can illustrate the application of that principle by a simple example. Out in the depths of space we see certain objects that we call stars and planets. It is not obvious from visual observation what those stars and planets are—at one time it was thought that they were simply holes in the sky that let the light shine through. Since then the properties of matter have been determined, where we are in direct contact with it, and some of the properties of the stars and planets have also been determined. The two have been correlated, and whenever a comparison has been made, they have been found to be identical. That justifies us, on the basis of the duck principle, in concluding that the stars and planets are aggregates of matter.

In exactly the same way we are identifying the electric charge as a distributed scalar motion. This is the same conclusion that I reached earlier in my theoretical works; but the situation is now entirely different. That theoretical conclusion had no meaning to anyone who was not willing to accept the premises on which it was based; and any scientist, or anybody else for that matter, had the option of accepting or rejecting it. That option is no longer open. We have now demonstrated that the identity of an electric charge as a distributed scalar motion is a necessary consequence of positively established facts, and the scientist has no option but to live with the facts.

What I have said so far covers essentially the same ground that I covered in the preliminary talk last year at Huntsville, and it may be that I have been imposing on those of you who heard the previous talk by subjecting you to the same thing twice. But there are two reasons for so doing. In the first place I wanted to emphasize the status of these findings with respect to distributed scalar motion as the equivalent of the result of a crucial experiment. The other reason is that it has been possible to extend those conclusions very materially during the intervening twelve months, and I wanted to talk to you a little about those extensions. My original intention, as I mentioned to some of those who were present at the conference at Huntsville, was to write an article for some appropriate scientific journal that would cover the scalar motion findings—and as soon as I got home from the conference, I started work on that article. But, coincidentally, I continued the investigations. And the results of those investigations accumulated so rapidly that it was very soon apparent that the idea of an article was impractical, and that the amount of material that I had could not be covered in anything less than a book-length presentation. So I proceeded with the preparation of the text of such a book, and in thinking over the subjects that might be of interest to you tonight, I decided that perhaps you might be interested in a sort of a preview of the contents of that volume.

Within the subject area that it covers, the conclusions reached in this new work will be identical with those reached in my previous theoretical works; but they will be reached by a totally different route. In the theoretical works I began with a set of postulates as to the properties of a universe of motion, and all conclusions in all areas were derived entirely by derivation of the consequences of those postulates, without introducing anything from observation or experiment. In this new work I am going to do exactly the opposite. I am going to start with a set of positively established facts, including those that have been derived from the scalar motion investigation; and all conclusions will be derived entirely by development of the consequences of those established facts, without introducing anything of a theoretical nature. That means that the entire book will be factual, without any tie-in to any physical theory. But since the conclusions will agree with the conclusions derived from the theory of a universe of motion, whereas they will disagree in many respects with current physical theories, the work as a whole will constitute a significant confirmation of the validity of the theory of the universe of motion.

The discovery and identification of distributed scalar motion was, in itself, an important advance in knowledge. But it also opens the door to a better understanding of the entities that are now identified as distributed scalar motions. One important point that has been clarified is the existence of multi-dimensional motion. Vectorial motion is one-dimensional. It may extend into three dimensions of space, but as motion it is confined to one dimension. Any such motion is described by a vector, which is one-dimensional; and any number of these vectors can be combined into a resultant vector, which is likewise one-dimensional. But scalar motions in different dimensions cannot be combined in any way analogous to the addition of vectors. It follows that scalar motions in different dimensions are independent. An n-dimensional motion, mathematically speaking, is simply one that requires n magnitudes for a complete definition. Thus a one-dimensional motion, or other physical quantity, can be defined by one magnitude; a three-dimensional scalar motion requires three magnitudes for its definition. One of those magnitudes, and only one, can be further subdivided by the introduction of directions relative to a spatial reference system. That motion can then be defined by a vector, and it can be represented in the spatial reference system by a line.

Current scientific thought regards the whole of existence, physical existence at least, as being contained within the space and time of the spatial reference system. And that current thought denies the existence of what I have just been talking about; that is, multi-dimensional motion. But now that we have derived the existence of multi-dimensional motion from established physical facts, it is evident that this current scientific opinion, which was never anything but an assumption, is an erroneous assumption. What we now find is that the conventional three-dimensional spatial reference system is capable of representing only a limited portion of the total contents of the universe.

With the benefit of this information as to multi-dimensional motion, we can now complete the definition of the basic distributed scalar motions. A study of the properties of electric charges, which I will include in the new publication, but won’t take the time to go into here, shows that the charge is a one-dimensional distributed scalar motion. A similar study of gravitation shows that gravitation is a three-dimensional distributed scalar motion. The situation with respect to magnetism is not as clear cut, because it is complicated by the existence of electro-magnetism, which is a phenomenon of an entirely different kind. But we can identify the so-called permanent magnetism as a two-dimensional distributed scalar motion.

In present-day thought these phenomena are dealt with as fields, but just what constitutes a field has always been a matter of a considerable difference of opinion. From Marshall Walker we get this definition: "A field is a region of space where a test object experiences a specific force." But Einstein disagrees. Einstein says a field is something "physically real" in space, "for the modern physicist as real as the chair on which he sits." This difference in opinion as to the nature of the field is further complicated by differences of opinion as to how the field theory ought to be applied and as matters now stand, the whole status of the theory is in considerable doubt. From David Park we get this assessment of the situation: "This does not mean that the ultimate explanation of everything is going to be in terms of fields, and indeed there are signs that the whole development of field theory may be nearer its end than its beginning." The clarification of the scalar motion situation shows that the field is neither a region of space as indicated by Walker, or something like the physicist’s chair, as indicated by Einstein. It is simply a distributed force. The force aspect of a vectorial motion is a vector; the force aspect of a distributed scalar motion is a field.

The failure to recognize important facts, such as the existence of distributed scalar motion, has a double effect in that it encourages the development of erroneous theories, and then causes a disregard of the facts that disagree with those theories. The situation with respect to gravitation is a good example. The observed facts with respect to gravitation are well known, and they are almost entirely disregarded. As nearly as can be determined from observation, gravitation acts instantaneously, without an intervening medium, and in such a way that its effects cannot be screened off or modified in any way. But those properties are so difficult to explain on the basis present-day theory that the physicists have resorted to the unusual expedient of constructing a fictitious set of properties that they *can* explain, and substituting those fictitious properties for the observed properties. Notwithstanding all evidence to the contrary, present-day physical opinion insists that gravitation *must* be propagated at a finite velocity, through a medium, or something with the properties of a medium. Einstein, of course, made space a medium—gave it the properties, as he said, of a medium. It is freely admitted that there is no evidence to support this present-day contention. As one prominent physicist puts it, "Nowadays we are also convinced that gravitation progresses with the speed of light. This conviction, however, does not stem from a new experiment or a new observation; it is a result *solely* of the theory of relativity." Once it is recognized that gravitation is a distributed scalar motion, all necessity for this defiance of the facts is removed, because the properties of a distributed scalar motion are exactly those properties of gravitation that have proved so difficult to understand.

The insistence on viewing gravitation as a transmission process also involves a wholesale disregard of the physical facts. That viewpoint likens gravitation to electromagnetic radiation, and we hear about gravitational waves in the same way that we hear about electromagnetic waves. But the two processes are entirely different, and it is very difficult to understand why anyone should ever connect the two. Electromagnetic radiation is an energy transmission process. A photon leaves an emitting object with a certain amount of energy. The energy of the emitting object is decreased by that amount. The photon travels through space and reaches an absorbing object, delivers the energy, and the energy of the absorbing object is increased by that amount. The intervening space, the distance, has nothing to do with the process, except in determining the time it takes for travel. The process is independent of the distance. In contrast to that process, the gravitational process is totally dependent on the distance. If there is no change in the distance, that is, if the two apparently interacting objects don't change their separation, then there is no change in the energy at all. And even if an energy change does take place, as happens in a case of an object falling towards the Earth, the increase in the kinetic energy of the incoming falling object is not obtained at the expense of the Earth: it's derived from the potential energy, the energy of position, of the falling object itself. Much the same considerations apply to electricity and magnetism.

There are a number of other direct consequences of the scalar motion existence that have an important bearing on various physical problems, and I intend to cover them, that is, all those that I have so far identified, in this new book; but I don’t want to take the time to talk about them here, because I want to leave time for adequate consideration of another very important finding, which, like the existence of distributed scalar motion, is significant enough to justify classifying it as the equivalent of the results of a crucial experiment.

This second important finding is a result of a well-known experiment, but it has not previously been recognized because a recognition of distributed scalar motion was a prerequisite for recognition of the new fact. As a preliminary, before starting to talk about that particular subject, I want to say a few things about speed limits. The present scientific view is that nothing physical can move faster than the speed of light. That belief is based on Einstein’s interpretation of certain experiments in which an electric force was applied to the acceleration of light objects, such as electrons. It was found in those experiments that the acceleration did not continue at the same rate as might be expected from Newton’s second law of motion, but decreased at high speeds at a rate which indicated it would reach zero at the speed of light. That indicated, of course, that either the force must decrease at high speeds, or the mass must increase. There is no physical evidence of any kind to indicate which is the correct alternative, so Einstein had to make a guess, and he guessed in favor of the mass alternative. According to his theory the mass increases at high speeds and becomes infinite at the speed of light. On this basis it is, of course, impossible for any higher speed to exist.

So far as present-day theory is concerned, it makes little difference which of these alternatives is correct, because there is obviously a limit on a one-dimensional basis in either case. Since present-day theory does not concede the existence of multi-dimensional motion, the existence of a one-dimensional limit is equivalent to the existence of a limit on speeds in total. But when we recognize the existence of multi-dimensional scalar motion, then it’s equally evident that the limit on speed in one dimension can be reached in each of the three dimensions. That does not mean that it’s possible to achieve a speed greater than light by electrical means, because, as I pointed out a little bit earlier, the electrical force is one-dimensional. That accounts for the fact that the electrical force was unable to reach any higher speed. But it does not preclude acceleration to higher speeds by means of some other process, such as, for instance, the release of large quantities of energy in violent explosions.

This brings me down to that second important physical fact that I have been talking about. But I want to pause for a moment to emphasize the continuing factual nature of the development of thought. The reason I need to do that is that the conclusion that I am now ready to pull out of the hat appears in the theory of the universe of motion as a postulate, and it has some far-reaching consequences. Those who realize that both the conclusion itself and the consequences are a part of the theory of a universe of motion are likely to suspect that I may have smuggled some theoretical considerations into the development of thought at some point along the line. So I want to assure you that that’s not the case. We’re sticking entirely to the facts.

We know from observation that the electric charge occurs only in discrete units. We have identified the electric charge as a distributed scalar motion. Now there’s no difference between this scalar motion and any other scalar motion so far as the motion itself is concerned: the difference is only in the nature of the coupling to the reference system. Once we have established that the electric charge, which is a scalar motion, is limited to discrete units, it then follows that scalar motion occurs only in discrete units.

Those of you who are encountering that conclusion for the first time may not be very much impressed by it. In fact, with all the build-up I have given it, it may come as somewhat of an anti-climax. But those of you who are familiar with the theory of a universe of motion will realize the great significance of deriving this conclusion from purely factual premises. At one stroke it raises a very substantial portion of the conclusions that have been reached with respect to a universe of motion from the status of theoretical conclusions to the status of established facts.

The only property of a scalar motion is magnitude; such a motion is a relation between a space magnitude and a time magnitude. Now we have further found that those are integral magnitudes, so that the properties of scalar motion are the properties of integral magnitudes. It then follows that we can derive the physical properties of scalar motion under any particular circumstances by translating the mathematical properties of reciprocal integers, which we already know, into the appropriate physical language. This, of course, is a general principle of extremely wide application.

In our ordinary view of motion the minimum amount of motion is zero; and zero is therefore the condition of rest, the condition from which effective magnitudes are measured. In a reciprocal speed system, on the other hand, the minimum speed is unity, because anything less than unit speed is not speed: it’s inverse speed. Similarly, the minimum inverse speed is unity. It follows that in such a system unit speed is the condition of rest, the condition from which all speed magnitudes are measured. Expressing that in another way, we can say that unit speed is the natural reference system. The natural reference system for scalar motion is not a fixed system; it is a moving system.

The motion of the time component is universally recognized. We all recognize that "now" is not something that stays put. It continually moves forward. The essence of the new finding is that "here" is an entity of the same kind: it likewise continually moves forward. What this means, then, is that all physical objects are continually being carried outward at unit speed relative to the fixed reference system.

In most cases that outward motion cannot be recognized; but where the gravitational effect is absent, as in the case of the photons of radiation, we can observe the outward motion: photons move outward at the speed of light. The same is true where the gravitational effect is practically negligible, as in the most distant galaxies, which are likewise moving outward at almost the speed of light. Another important consequence of the reciprocal relation that we have now established is the symmetry around unit speed which means that there is motion in time as well as in space. An increase in the time, while the space is constant, results in a decrease in space per unit time, and therefore causes a change of position in space. An increase in space with time remaining constant decreases time per unit space and causes a change of position in time. So here we arrive at the concept of a motion in time. This concept is perfectly familiar to those of you who have been dealing with the theory of a universe of motion; and a great deal of what I am saying now is very much the same as I was saying years ago when I was first explaining that theory. So it’s old stuff to you. But it has a quite different significance in the present context. The extent to which we can now derive these conclusions from established facts greatly strengthens the position of the theory. Many individuals have rejected our conclusions without any serious consideration simply because they conflict with ideas of long standing that have had no basis other than assumptions to begin with. But now that we are able to show that these conclusions are consequences of positively established facts, that option, as I said with regard to another item, is no longer open. Scientists have no option but to accomodate themselves to the facts.

The system of scalar motions that we can represent in the spatial reference system, the one-dimensional motion that I was talking about earlier, can be duplicated in time because of this space-time symmetry, so that we have another system equivalent to the scalar motion system that is represented in our reference frame. The derivation that I am giving you now deals only with scalar motion, and we’ll have to leave vectorial motion for consideration at some other time, because I haven’t brought that within the factual limits yet. But we can consider this point: that gravitation is a scalar motion, and that consequently all gravitating objects are included in the inverse system. This includes all material objects. It follows that the inverse system is at least co-extensive with the system that is open to observation, whether or not it is an exact duplicate. The inverse system that I have been talking about is a system of maximum speed. The system that we are well acquainted with, that we deal with on our ordinary reference system, is a region of minimum speed.

Now I want to take a brief look at some of the things that happen in the intervening area. First, we need to look at some of the primary processes that are involved. The progression of the natural reference system is outward, a plus or positive motion in our usual language. It is limited to one unit, because that is the maximum that we can have in a system of discrete units. Gravitation is capable of extending to two units before it reaches a net resultant of one negative unit; and to that one negative unit we can apply outward translational motion in one dimension. Here we again have a range of two units. The same is true in each of the three dimensions. That gives us then a total separation of six units of speed from one zero to the other.

So far I have been talking about full units. Of course, when we exclude fractional units, we don't have anything *but* full units, but we can produce the equivalent of a fractional unit by adding units of the opposite kind, that is, units of motion in time. N units of motion in time are equivalent to minus 1/n units of motion in space—so that we accomplish a resultant of less than one unit by combining the one full unit with the oppositely directed fractional unit from the other direction. This is the first speed range, the range from zero to one unit. It is the range of our ordinary experience, the speed range that's represented in the spatial reference system. It's not possible, obviously, to exceed one unit by any kind of a subtraction from a single unit, which accounts for the limitation on the speed in one dimension. But there is nothing to prevent the addition of another full unit, so that in the next speed range, we have *two* units minus a fractional unit. The same is true in the third speed range.

It's necessary to keep in mind that the first of the two units is a unit of space and that there is a unit of time in the same dimension. There is a unit of space from zero space to unity, which is the unit of both space and time, and another unit from this unit level to zero time. Thus, the second unit of motion is in time. Then, in order to add a third unit, we have to go to a second dimension, so that again we have a dimension of space. On this basis the speed from zero to one unit is in space. That's the ordinary motion that we are acquainted with. A speed from one unit to two units is in the same dimension, but it is in time. A speed from two units to three units continues that unit of speed in time, but adds a unit of speed in space, so that it's two-dimensional.

These are the major characteristics of high-speed motion as we derive them from the reciprocal relationship that we have just found. In order to give this a meaning in terms of our physical observations, we have to resort to the identification process again. The most energetic processes that we know of in the universe are explosions of stars and galaxies. If any objects with speeds in these intermediate ranges that I have been talking about actually exist, they must exist as objects of that kind. So let's look at them. All violent explosions generate some low-speed products, and we see those low-speed products expanding away from the site of the explosion, usually at high speeds. Those products are not of particular interest to us now because they are in the lower speed range, the ordinary speeds of our everyday experience. But in motion in the second speed range, the change of position is in time. So that the motion in that speed range produces the same kind of a cloud of expanding particles, but this time they are expanding into time. Because of the reciprocal relation between space and time that I have just been talking about, the cloud of particles expanding into time decreases in size as seen in the spatial reference system, so that we observe such a cloud of particles as a very small object of a very high density, which remains in essentially the original location. Such an object can, of course, be identified with the stars that we know as white dwarfs. So here, then, we can identify objects in which the speeds are in the second speed range—from unity to two units. This is another conclusion we reached theoretically, but now we find that we have sufficient evidence to establish it as a consequence of positively established facts.

We also have evidence that there are explosions of galaxies, and since these are very much larger objects—our own galaxy contains something like ten to the eleventh power solar masses, a hundred billion times the size of one star—the explosion of a galaxy is very much more violent, we can therefore deduce that some of the products of that explosion will probably enter the third speed range. As I pointed out a short time ago, that should have two consequences. Because it has a two-dimensional motion, one dimension of which is in time and another in space, that kind of an object will be moving rapidly outward, as well as decreasing in size, like the white dwarf star. Such an object will therefore be the equivalent of what we might call a white dwarf galaxy; not a galaxy composed of white dwarf stars, but a galaxy that has the properties of white dwarfs. We can easily identify this as one of the objects known as quasars.

Now, to summarize what I said: I have not been able to find the kind of a crucial experiment that I and others have been looking for. But by means of a systematic analysis of previous experimental work, I have uncovered two hitherto unrecognized facts of a crucial nature—the kind of facts that would have been obtained from crucial experiments, if I had found such an experiment, or two of them. These new crucial facts are, first, the existence of distributed scalar motion, and, second, the limitation of all scalar motion to discrete units. With the benefit of these new crucial items of information, many of the unique features of a universe of motion, including multi-dimensional motion, motion in time, speeds greater than that of light, and a second half of the universe, can now be presented to the scientific community as established facts, rather than as theoretical speculations. This should aid very materially in the continuing effort to secure the serious consideration that has thus far been so difficult to obtain.

The Mythical Universe of Modern Astronomy

A Lecture given in Philadelphia on August 12, 1982

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For the past two years, I have been spending all of the time that I could make available for the purpose of the preparation of additional volumes of the revised edition of my first book, The Structure of the Physical Universe. As I think most of you know, the first volume of that revised edition has already been published with a separate title of Nothing But Motion, and I am now working on the next two volumes, concentrating mainly on volume III, which will probably be completed and published ahead of volume II. That may seem like the wrong way of going about it, and perhaps it is, but there are good reasons for it, which I won't go into now.

Volume III [Universe of Motion] is the astronomical volume. In that I am taking the physical laws and principles developed in volumes I and II, and applying them to the astronomical situation. The results that I have obtained in so doing are quite different from what you find in the astronomical literature—so much so, in fact, that you might almost wonder if we are talking about the same thing. And I am quite sure that those who read the book will want to ask a question that goes something like this: If your results are correct, how in the world did the astronomers arrive at such totally different conclusions? Since that question is going to be asked, I think that I should answer it right in the book itself and I am planning on putting in a chapter for that purpose. What I propose to do this evening is to give you a general idea of the contents of that chapter.

What the astronomers have done is essentially the same thing that I've done. That is, they have taken the physical laws and principles to which they subscribe and have applied them to the astronomical situation. The difference is that I have had the benefit of a general theory, one in which all conclusions in all fields are derived from the same set of basic premises. So that when I make the assumption that the laws and principles that I am using are correct—that's something all of us have to do in order to establish the logical foundations of our results—I can do the whole thing with one assumption. The astronomers can't do that, because conventional physical theory has no general physical structure. As described by one prominent physicist, Dr. Richard Feynman, in a quotation that I have given many times before, *"The laws of physics are a multitude of parts and pieces that do not fit together very well."* So when the astronomers assume the validity of the laws and principles that they are using, they have to make an assumption as to the validity of each one individually, and they have to make a multitude of assumptions, thousands of them. Almost all of those laws and principles are, in fact, valid. I would estimate that not more than one in a hundred or even one in several hundred has anything significantly wrong with it. And on that basis the astronomers have at their disposal a system of laws and principles that is at least ninety-nine percent valid; so it might be assumed, then, that the results that they obtain ought to be at least somewhere in the neighborhood of ninety-nine percent correct. But that's not the way that things work. On the contrary, it can easily happen that if the basic premises are only ninety-nine percent correct, the results may well be ninety-nine percent wrong.

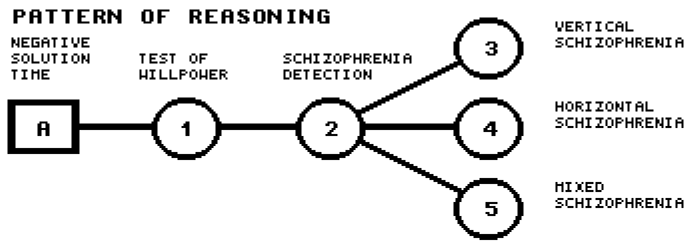
That’s the principle on which much of our science fiction is based, particularly the better grade of science fiction. And to illustrate how it operates, I want to discuss briefly a science fiction story of that kind. The one I’ve chosen for the purpose is Isaac Asimov’s story of the remarkable properties of the substance that he calls Thyotimoline. As he tells the story, a group of investigators are working on a project the objective of which was to produce a substance with a very short solution time, that is, one that would go into solution very rapidly. And they succeeded very decidedly. They produced substances with shorter and shorter solution time until eventually they were able to synthesize a substance with a negative solution time, one that went into solution somewhat before it was placed in the solvent.

Now, I imagine you can readily understand that that led to some very interesting practical applications. For example, it enabled the construction of an instrument to measure willpower. Obviously, the material would not go into solution as long as there was any doubt about whether it would or would not be placed in the solvent. So that the maximum possible theoretical negative solution time could only be developed by a person with strong willpower, one whose determination was such that once he had decided upon putting the material in the solvent, he would be sure to carry out the operation. On the other hand an individual who’s hesitant or undecided would only be able to develop a fraction of the possible negative solution time. So that by a proper calibration of the instrument the measurement of negative solution time could be interpreted in terms of willpower.

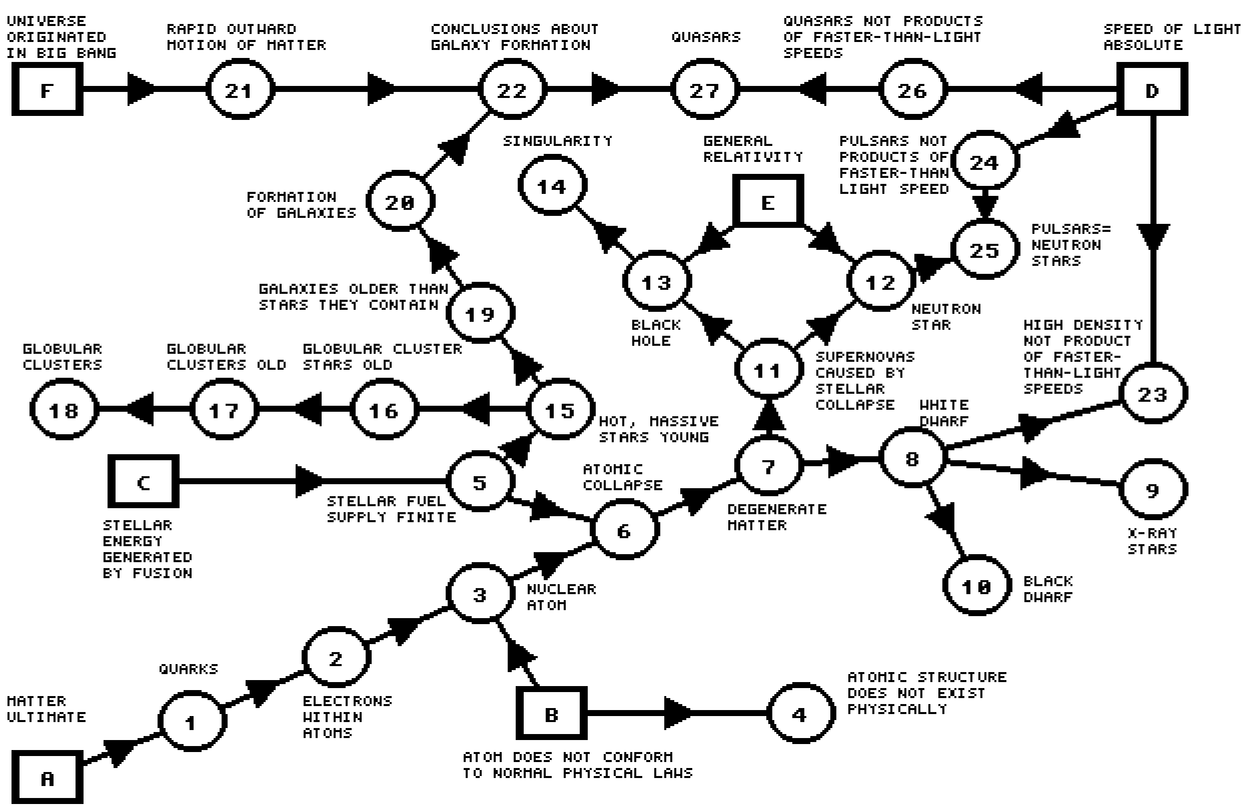
Now you can see that that instrument would have a wide application. For instance, it was not only a valuable tool for measuring willpower, but it also enabled a quick and accurate diagnosis of schizophrenia. A person with a split personality would naturally have two different levels of willpower. So that when he was tested with the instrument, there would be a period of time during which one portion of the material would go into solution, while the other portion remained undissolved. Now that was not only a valuable diagnostic tool: it also enabled the investigators to discover some different types of the affliction that were previously unknown to the psychiatrists. For instance, there was horizontal schizophrenia. In that type, one layer of the material dissolved, while another layer remained undissolved. And then there was vertical schizophrenia, in which the same difference was noted between right and left halves of the container. And then there was mixed schizophrenia, in which the undissolved material was scattered at random throughout the solvent.

Now, Asimov goes on to describe a considerable number of other applications of a similar nature; but these that I have given you are all that we need for present purposes, because what we’re interested in is the structure of the story. As Asimov himself explains in his discussion of the story, there is only one assumption contrary to fact introduced into that story. Everything else is strictly according to Hoyle, and the lines of reasoning are sound. So that what we have here is the kind of thing that I have been talking about, a situation in which ninety-nine percent of all what goes into the story is correct, but the whole thing turns out to be nothing but entertaining nonsense, and it culminates in such absurdities as vertical schizophrenia.

I have illustrated that structure of the story in the diagram that has been passed out. You will note that the one contrafactual assumption is identified by letters, and then the lines of reasoning lead out to the successive conclusions.



The astronomer's structure of the universe is exactly the same kind of structure, except that they introduce many assumptions contrary to fact, and their universe, the structure of their universe is therefore much more complex. When I talk about structure in that connection, what I am actually talking about, of course, is the framework of the structure. The astronomical universe includes many entities and processes, such as stars, planets, galaxies, and so on, that have to enter into any version of the structure. But those entities and processes are like the side panels and ornamentation on a building. They're just hung on to whatever framework may exist. And it's the framework that determines the character of the structure. It's that framework that I have indicated here.



I have shown the assumptions contrary to fact by letters, just as in the lower diagram, and from them the lines of reasoning, generally sound, lead out to the numbered conclusions, with arrows showing the direction of the reasoning. Where the numbered conclusions refer to entities or processes that are totally non-existent, I've also shown the names. Those numbered conclusions that are not accompanied by names refer to entities or processes that actually do exist, but that differ in some significant way from the description that we get from the astronomers. For example, over on the right of the diagram, conclusion number nine refers to what are known as X-ray stars: they are discrete sources of X-ray emission in the galaxy. Those are actually binary star systems as the astronomers say they are. But one member of each binary system is a quite different object from the one that's portrayed by the astronomers, and the process by which the X- rays are emitted is totally different.

There's one more feature of the diagram as a whole to which I want to call your attention before I start tracing the lines of development. And that is the cumulative effect of more of these assumptions contrary to fact. If you look over on the upper left of the diagram, you will see that the numbered conclusions there are subject to the effects of only one of these contrafactual assumptions, and as a result none of those is listed as totally non-existent. Actually, some of those conclusions are wild enough in themselves, as we'll see when we come to look at them individually, but the real dillies are over on the other side of the diagram, where the effects of three, four, or five of these contrafactual assumptions converge.

The first of the assumptions contrary to fact to which I want to call your attention, the one marked A on the diagram, is the assumption that the basic entities of the universe are elementary units of matter. That assumption seemed very reasonable when it was first made. But we now know definitely and positively that it's wrong, because we now know that there are processes whereby matter can be converted to non-matter and vice versa. And obviously, that means that matter cannot be basic. For example, radiation is not a form of matter, and matter is not a form of radiation. But matter can be converted to radiation. Consequently, it necessarily follows that both matter and radiation must be forms of some underlying entity, some common denominator, we may say. That's not a question of opinion or judgement; that's a necessary consequence of the observed facts. The relevance of that point in this present connection is that it sets a limit on the extent to which units of matter can be subdivided into simpler units of matter. For example, if we start with a rock and examine its structure, we find that it is composed of identifiable material sub-units that we call molecules. But if we continue that process, we eventually come to a material unit that is clearly not elementary, but for which we cannot find any sub-units.

The logical conclusion then is that we have arrived at the point that we know exists, the point where the material unit is not composed of material sub-units, but is composed of the common denominator, whatever that may be. That's the logical conclusion. But the physicists and the astronomers cannot accept that logical conclusion, because they are committed to assumption A which says that the basic units are units of matter. Consequently they have to go out and invent the units that they cannot find. That is the essence, the basis of the quark hypothesis, number one on the diagram. Many prominent scientists have recognized the fallacies in the quark hypothesis. Werner Heisenberg, for instance, was very critical of it. And he also recognized the necessity for a common denominator between matter and non-matter. He suggested that it might be energy; but he admitted that he couldn't see how energy could meet the requirements.

In a universe of motion the common denominator is, of course, motion. But strangely enough, these scientists who have been so able to see the shortcomings of the quark hypothesis have not usually seen that exactly the same considerations apply to the particles that are supposed to be constructed of quarks—the hypothetical constituents of the atom. No one has been able to find them either. Of course the situation has been confused to some extent in this case by the practice of calling those hypothetical constituents by the names of observed particles. But, as I pointed out in my talk at the conference last year, that practice is totally unscientific.

Identity cannot be established by similarity in names. It has to be established by identity of the descriptions. In scientific terms, two entities are identical in nature if all of their properties coincide. If the bird that we see quacks like a duck and swims like a duck, and so on all the way down the line, then it's a duck. If it crows like a rooster and can't swim, then it's not a duck. It doesn't make any difference how many people insist on calling it a duck, or how nice it would be for somebody's theories if it were a duck—it still isn't a duck.

The same identical principle applies to these particles. The observed neutron, for instance, is an unstable particle: it has a life of less than fifteen minutes. And it's gregarious: it has a strong tendency to combine with almost anything that comes along. The hypothetical neutron constituent of the atom, on the other hand, has to be stable. And it has to maintain its identity even in places where the tendency toward combination is very strong. The pure fact is that they are two totally different particles. Of course, the theorists tell us, the neutron is an accommodating thing, and if we put it in the atom, it will accommodate their theories by becoming stable and by discontinuing this awkward habit of combining with other things. But that's pure nonsense. That's in the same category as saying that if we throw the rooster in the water he will quack and start swimming.

The situation with respect to the other hypothetical particles in the atom is no different. In fact Herbert Dingle tells us that we can't even imagine a particle with all of the properties that are required of the hypothetical electron constituent. But with these imaginary particles (number two on the diagram) the theorists have constructed an imaginary atom (number three).

But even with all of the leeway that they have had for making assumptions as to the properties of these particles of which they wanted to build an atom, they could not construct a plausible theory without making another assumption contrary to fact, the one marked B on the diagram. That is the assumption that the atom does not conform to the normal laws of physics. That's a drastic assumption, and because of that drastic assumption the people who put this structure together in the first place, have had to make the admission that their atom is not a real particle—that's number four on the diagram. As Heisenberg puts it, *"It is in a way only a symbol."* Irwin Schroedinger tells us, *"If the question is asked, do the electrons actually exist on these orbits within the atom, the answer has to be a decisive no."* And Heisenberg specifically cautions us that we must not think that the physicists' atom is a material particle in space and time that exists objectively in the same sense that stones and trees exist. Then what sense does it exist in? Well, he tries to explain that, and he says this: *"The atom of modern physics can only be symbolized by a partial differential equation in an abstract multi- dimensional space."* Now when we translate that from the professional jargon of the physicist to the vernacular, we find that it says exactly the same thing that I have been saying. The physicists' atom is an imaginary atom constructed of imaginary particles. And in this connection I want to point out that these people that I have been quoting are not scientific heretics like the present speaker. They are eminent members of the group that puts this thing together in the first place. When the present-day physicist wants to apply quantum theory to his problems, it is Schroedinger's wave equation that he tries to solve. Now when he gets into difficulties, it's Heisenberg's principle of uncertainty that he calls on to get him out of those troubles.

In order to go any farther along this line of development that I have started tracing, the astronomers have had to make still another assumption contrary to fact: like the first two, this one was borrowed form the physicists. It's their assumption as to the nature of the process whereby energy is generated in the stars. The physicists' attitude on this subject has never changed. They have contended from the very first that whatever the most energetic process known to them might be, that must be the stellar energy generation process, regardless of how much evidence might exist in any other field of science. The fact that they have had to change their ideas as to the nature of that process twice already, the last time under very embarrassing circumstances, has not changed their attitude in the least. Today there is ample astronomical evidence that their present assumption (assumption C) is wrong, just as there was ample geological evidence in the nineteenth century to show that their then current assumption was wrong. But the physicists are no more willing to listen to the astronomical evidence today than they were willing to listen to the geological evidence during the long and acrimonious dispute with the geologists in the nineteenth century. And since the astronomers are not willing to put up with the kind of fight that the geologists did, they have ignored or rejected the evidence from their own field, and have accommodated their evolutionary theories to the physicists' assumption C. I will have some more to say about the astronomical evidence when we come back to this side of the diagram and start up the line toward conclusion fifteen. But for the moment I want to continue along the original line of development.

The first conclusion that is derived from assumption C is the conclusion that the supply of energy in the stars will eventually be exhausted—that's conclusion five. The astronomers have then taken that conclusion five and put it together with conclusion three, the conclusion as to the nature of the atomic structure, and they have arrived at the further conclusion that the result will be a collapse of the atom.

I said earlier that the lines of reasoning represented by the lines on the diagram are generally sound; the reason for putting in that qualifying word "generally" is that I have some reservations in some cases, and this line of reasoning leading to conclusion six is one of them. One of the results of the application of thermal energy to a material aggregate is to introduce additional space between the atoms or between the molecules of the aggregate. And if we eliminate that thermal motion by exhaustion of the fuel supply, it's logical to assume that that exhaustion of the fuel supply also eliminates some further space in the interior of the atom that the thermal motion had nothing to do with in the first place. The justification for that kind of an assumption is very hard to see. Of course, some of the theorists tell us that when the support given by the thermal pressure is eliminated, the aggregate collapses of its own weight. But that is equivalent to assuming that material is heavier when it's cold than it is when it is hot. And there again, that's an assumption that's very difficult to swallow. In the real world the atoms at the bottom of the pile are subject to the weight of all the overlying layers, regardless of whether they are hot or cold.

In one of the books from which I and my contemporaries learned to read, there is a story about a man who is going home with a heavy sack of flour. (In those days, I might say, we bought flour in hundred- pound sacks, not in these little bits of things that they sell in the supermarkets). This man was afraid that the heavy weight would be too much for the horse that he was riding, so in order to relieve the weight on the horse he picked the flour up and held it in his arms on the way home.

Now when we were children we laughed at that story. But now we're presented with exactly the same proposition by the astronomers, in a little different language, and we're expected to keep straight faces. But, after all, I suppose we'll have to remember that what you or I may think about this situation is not relevant in the present connection. What we're trying to do is to examine how the astronomers have arrived at these conclusions, and this is their conclusion, number six, and they have concluded, then, that the material of the star collapses into a weird condition that they call "degenerate matter," in which all of the hypothetical space in the hypothetical atom has been eliminated and these hypothetical constituents are in a close-packed condition.

Since this degeneracy starts from a condition in which the material is cold, and therefore solid, it would seem natural to assume that the degenerate matter should be some sort of a super-solid. But no, that's not what they tell us. In some strange way it re-acquires some of the properties of a gas. Particularly, it acquires a substitute for the thermal motion that it can no longer have. So that then instead of cold matter, we have an aggregate of hot degenerate matter—that's conclusion number seven—and they have identified that aggregate of hot degenerate matter with the white dwarf star—conclusion number eight.

I have already mentioned number nine, which is the X-ray star. You will also note that the white dwarf, number eight on the diagram, is connected with item number twenty-three: but that's an incoming line. That refers to the effect of contrafactual assumption D on the white dwarf. Now this assumption D has an effect that is quite different in its nature from the effects of the other contrafactual assumptions that I am discussing. So it will be convenient to defer the effect shown by number twenty-three until we are ready to talk about the situation in the conclusions along the top of the diagram.

So let's move on then to conclusion number ten. The ersatz heat of the white dwarf is supposed to be radiated away in the same way as real heat, although nobody's explained why that should be true. And since that's radiated away, the white dwarf is presumed to gradually cool off, and eventually to become a black dwarf, a cold lifeless object that plays no further part in physical activity. These black dwarfs are purely hypothetical. There is no evidence whatever of the existence of any such thing. And there is no definite evidence that the evolution of the white dwarf is in the black dwarf direction. on the contrary, there is a great deal of evidence showing that some stars, and perhaps all of them, end their lives in gigantic explosions.

The astronomers have had to recognize that evidence, of course, and they've compromised: they've decided that the small stars collapse quietly, and end their lives as black dwarfs, and the big stars explode. And they have identified that explosion with the observed phenomenon now as the supernova. That's number eleven on the diagram. The effect of a gigantic explosion of that kind is to pulverize the material of the star and to eject it out into space in the form of a rapidly expanding cloud of dust and gas. But the astronomers have concluded, and they have some evidence to support that conclusion, that a residue remains at the scene of the explosion. And they have identified that residue as degenerate matter. But they have decided that because of the force of the explosion this matter is more degenerate than the degenerate matter of the white dwarfs. And in some strange way that sounds like magic to me, all of the hypothetical constituents of that degenerate matter are converted to neutrons. So that what we have left is a star composed entirely of neutrons—a neutron star, number twelve in the diagram.

On the basis of some mathematical conclusions the astronomers have further concluded that there is a limit to the size of a neutron star, and they have decided that when the residue exceeds that size, the contraction under the influence of gravitation goes on until the surface gravity of the aggregate is so strong that no radiation at all can escape. What then exists, they say, is a black hole, conclusion number thirteen. Some theorists are not even willing to stop there. They contend that the contraction under the influence of gravity goes on and on until there's nothing left from the whole star but a single point—a singularity, in scientific jargon (that's conclusion fourteen).

As you can see from the diagram, all of these bizarre conclusions as to the products of the supernova explosion are subject to the effects of all four of the assumptions contrary to fact that I've already mentioned. And in addition they're subject to one more, which I've identified by the letter E on the diagram. This assumption involves some very basic issues, and I won't be able to explain it in detail in the time that I have this evening, but I can say that in essence what it amounts to is an assumption that the astronomers understand the mechanism of gravitation, which obviously they don't. Again I want to call on Dr. Feynman. he says, *"No one has given us the machinery of gravitation; all we have is the mathematical form."* Now Dr. Feynman is evidently not familiar with the theory of the universe of motion, because we have given the machinery; but his statement is correct in application to the conventional physics that the astronomers are using.

Now here is a little gem for your collection. *"Of all the conceptions of the human mind, perhaps the most fantastic is the black hole. Like the unicorn and the gargoyle, the black hole seems much more at home in science fiction or in ancient myth than in the real universe."* If you were not told otherwise, you would probably think that that came from me or from some other hard-boiled skeptic. But no, those are the words of Kip Thorne, one of the most enthusiastic advocates of the black hole hypothesis. Of course, he contends that black holes must exist anyway, no matter how fantastic they are. And after making that statement, he goes on to say this: *"The laws of modern physics virtually demand that black holes exist."* That's absolutely correct.

The whole point of my presentation then is that all of these absurdities, the black holes and the rest of them, are required by the current laws of physics and the current interpretations of those laws by the astronomers. And that is because those laws and those interpretations have not been purged of the effects of these assumptions contrary to fact that I have been talking about. The black hole is not science fiction; it's fictional science. The difference is that the science fiction writer knows and admits that he is using assumptions contrary to fact. The practitioner of fictional science either doesn't know or is not willing to admit that he is doing exactly the same thing. The black hole is the astronomical equivalent of vertical schizophrenia.

Moving back now to the other side of the diagram, we note that one of the results of conclusion number five, the conclusion as to the exhaustion of the fuel supply, is that the hot massive stars must be young because they are using their fuel at such a prodigious rate that the exhaustion must come relatively soon, astronomically speaking. This is an inherently improbably conclusion, and a great many astronomers have recognized that. Bart J. Bok, for instance, tells us this: *"It is no small matter to accept as proven the conclusion that some of our most conspicuous supergiants, like Rigel, were formed so very recently on the cosmic scale of time measurement."* And indeed this is no small matter. What Bok evidently realized is that the product is inconsistent with the process. Natural building processes are slow and gradual. The rapid processes, the catastrophic processes, are destructive. Some new combinations may emerge from those processes, but they're no more than incidental. The general effect of those processes is to tear down, not to build up.

It's generally agreed that the raw material from which the stars are formed must be diffuse matter in the form of dust and gas clouds, and if stars are currently forming, those must be cold clouds. The only known force that is capable of drawing the particles of those clouds together to form stars is gravitation. And because of the immense distances involved the force of gravitation is very weak, and it takes a long long time to operate. The formation of a star is therefore a long, slow process. And the initial product, because it is formed from a cold material, is a cool star, not a hot one. In order to form a hot massive star, another long slow process is required. So that the hot massive star cannot be young, it's an old star. There is plenty of astronomical evidence to support that finding. Most of it comes form observation of the star clusters. Since we find that conclusion fifteen is an erroneous result of an assumption contrary to fact, the same considerations also apply to conclusion number sixteen, and they show that the astronomers have their age sequence upside down. Now they will protest that they have evidence to support that age sequence. But if you examine that evidence, you will find that most of it is evidence only of the existence of a sequence and it has nothing to do with a direction. And those items which do refer to the direction of the sequence contradict the astronomers' conclusions. The most conclusive of that kind of evidence comes from the small clusters that are located in the galaxy, rather than around it. Those clusters, the galactic, or open clusters, can be divided generally into two groups. In one group the constituent stars resemble those of the globular clusters. In the other group they are more like the general run of stars in the galactic arms, such as those in the solar neighborhood. These clusters of both groups are all expanding at measurable rates, and their star density, the number of stars per unit volume, is therefore decreasing. Since there's no reason that we know of why the initial conditions should be any different, it follows that the clusters with the greater average density are the younger, and those with the smaller average density are the older.

Here, then, we have something that is very rare in astronomy—an opportunity to determine the direction of evolution from direct observation. Now according to studies that have been made, the astronomer Otto Struve tells us, the average density of the group composed of the stars of the globular cluster type is the greater. This is therefore identified as the younger group, which is the opposite of the conclusions reached by the astronomers.

Now this is not the only astronomical evidence that shows that they have their sequence upside down, there are quite a number of other items that I won't be able to discuss tonight because we just simply haven't enough time. But there is one item among them to which I do want to call your attention, because it has a particular significance. This item has to do with the age and origin of the globular clusters. If the stars of those clusters are old, as contended by the astronomers (conclusion number sixteen) then the clusters themselves are presumably old—

that's conclusion seventeen. And the astronomers have therefore decided that they must have been products of the original process of galaxy formation, and are part of the galactic structure—that's conclusion eighteen. This view encounters some very serious difficulties. One of the most obvious of them is that the clusters do not participate to any significant degree in the galactic rotation, and that is very hard to explain if they are part of the galactic structure. But since conclusion eighteen is a logical result of this line of reasoning, stemming from assumption C, to which the astronomers are committed, they have continued to hold on to this conclusion in spite of all the difficulties, hoping that they will ultimately go away.

But alongside this orthodox evolutionary view of the astronomers, there has in recent years grown up a new concept that contradicts the whole setup. And since that new concept is accepted quite widely in the astronomical profession, that profession is now in the awkward position where they, or at least a substantial segment of their profession, accept two contradictory explanations for the same thing. This new concept is the concept of galactic cannibalism. Quoting the astronomer Wallace Tucker: *"The majority of galactic clusters are dominated by a single massive elliptical galaxy. Apparently these monster galaxies have eaten dozens of their smaller companions."* Now obviously, if the giant galaxies can swallow the spirals in their vicinity, the big spirals like ours have the capability of swallowing dwarf galaxies and globular clusters. And in the light of that information, the presence of large numbers of globular clusters surrounding every one of the major galaxies takes on a new significance. In the light of that information it's evident that those globular clusters are not part of the galaxy—they're external objects that are being drawn in where they can be conveniently swallowed.

Now in that connection it's worth noting that the motions of those clusters that are so difficult to explain on the basis of the astronomers' conclusions, fit in very nicely with the cannibalism hypothesis. Again I want to quote the astronomer Otto Struve. He says they move *"much as freely-falling bodies attracted by the galactic center."* Of course, on the basis of this new concept, that's just exactly what they are.

Returning now to conclusion fifteen, another one of the consequences of the astronomers' age sequence (conclusions fifteen and sixteen) is that stars must be currently forming in the galaxies, because there are a great many of these hot massive stars in the galaxies, particularly in the galactic arms, and according to the astronomers' viewpoint, those must have been formed fairly recently, and close to their present locations. That confronts the astronomers with a very difficult problem. As I mentioned earlier, the force of gravitation is capable under appropriate circumstances of pulling the particles of the dust and gas clouds together to form stars. The difficulty arises because those appropriate circumstances do not exist in the galaxies.

In order to enable the force of gravitation to do the job unassisted, the dust and gas clouds in the galaxies would either have to be very much larger or very much denser than anything that now exists in the galaxies. So that the astronomers, in order to maintain their theories, have had to try to find some auxiliary process that could work in conjunction with gravitation to produce these results. And they have examined quite a number of processes that they thought might work, but so far they have been unable to produce anything that could stand up to critical scrutiny.

So the result is, as described by an astronomer, Simon Mitten, *"The process of star formation is almost a total mystery."* When we correct the evolutionary direction, and turn the sequence upside down, the problem disappears; because on that basis there are no stars in the galaxy that are young in absolute terms. It's true that on that basis the stars of the globular clusters, or of the globular cluster type, are younger than the hot massive stars, but that doesn't mean that they are young in absolute terms. It does not preclude their having been formed in some region where the appropriate circumstances for star formation do exist, and having been brought into the galaxy by the capture process.

But since the astronomers accept this conclusion that the stars are currently being formed in the galaxies, they have had to arrive at another conclusion, number nineteen, the conclusion that the galaxies are older than the stars that they contain. As it's expressed in one textbook, *"According to current conceptions in astrophysics, the galaxies were born first in the universe, and the stars within the galaxies were born afterward. The main reason for believing this to be true is the fact that stars can be seen forming in the galaxies at the present time out of gas and dust."* Of course, they can't be seen forming, he merely means that the conditions are such that the theory says that that's where they are forming. Now these ideas as to galaxy formation, conclusion twenty, are very vague. John B. Irwin describes them in this manner. *"The Milky Way system, like other galaxies, is thought to have originated from a condensation or collapse of the intergalactic medium. The reason for the collapse is not known, and the details of the process are uncertain."* What Irwin is in fact telling us is that astronomers known all about the galactic formation process, except the general nature of the process and the details. L.H. John puts the situation into perspective in this statement: *"The encyclopedias and popular astronomical books are full of plausible tales of condensation from vortices, turbulent gas clouds, and the like, but the sad truth is that we do not know how the galaxies came into being."* These are astronomers I am quoting, they are not scientific heretics.

The reason for the difficulty the astronomers are having can be easily understood if it is recognized that their conclusions about the galaxies, number twenty-two on the diagram, are derived not only from this conclusion twenty, which is the result of the line of reasoning that we have been following, but also from a conclusion twenty-one that directly contradicts conclusion number twenty. This conclusion twenty-one is derived from another assumption contrary to fact. That's the astronomers' assumption that the universe, or at least the present stage of the universe, originated in a gigantic explosion, the Big Bang as it is called. If they applied the same reasoning that they used in determining their ideas as to the consequences of the supernova explosion, then the explosion that they call the Big Bang would have ejected one part of the material of the universe out into space at high speeds, in the form of an expanding cloud, while another part of the material would have been left at the scene of the explosion in the form of a gigantic black hole. But they are already having serious difficulties in finding some reason why the universe is so isotropic. And if they put a black hole out in the middle somewhere, that would compound the difficulties. So they conveniently ignore what they decided over on the other side of the diagram and on this side of the diagram they decide that the entire contents of the universe, as one textbook puts it, *"All of the matter and all the radiation in the universe"* is ejected out into space in the form of an expanding cloud.

Now the problem comes then to explain how these particles could have been moving outward at high speeds ever since the Big Bang as required by conclusion twenty-one, and at the same time aggregating into galaxies, as required by conclusion twenty. If you stop to think about that for a little bit you'll understand why the astronomers are having such difficulty, and why their ideas about the formation of galaxies are as vague as these statements have shown them to be.

We've now arrived at the point where we need to take contrafactual assumption D into consideration. As I said earlier, the effects of that conclusion are exerted in a manner that is somewhat different from those of the others. Those other conclusions that I have mentioned tear down the barriers that separate fact from fiction and they permit the astronomers to extend their theories into regions that do not actually exist. The effect of conclusion D, on the other hand, is to set up barriers that prevent them from extending their theories into areas that actually do exist, and they force them to invent various kinds of substitutes.

The effects of this conclusion D, which is Einstein's conclusion that the speed of light is an absolute speed limit, are expressed in the form of three prohibitions—number twenty-three, number twenty-four, and number twenty-six on the diagram. Number twenty-three decrees: *"Thou shalt not think of speeds greater than that of light in connection with the high density of the white dwarfs and the products of the supernova explosions."* It is this prohibition that forces the astronomers into the strange contortions of thought that result in black holes and singularities.

Number twenty-four similarly dictates, *"Thou shalt no think of speeds greater than that of light in connection with the intermittent radiation from the pulsars."* The pulsars are number twenty-five on the diagram. And you note that the pulsars get a double dose: they're subject to the prohibitions both twenty-three and twenty-four. The result of this double prohibition can be seen in the present state of knowledge in the field. According to Dr. F.G. Smith, one of the leading investigators in the area, *"the manner in which the pulsars are produced is not understood, and little is known about the mechanism of the radiation."* That's the result of being prohibited from entering the field of high speeds.

Item twenty-six is another edict, *"Thou shalt not think of speeds greater than that of light in connection with the quasars."* And since almost all of the observable features of the quasars are a result of speeds greater than that of light, the result is that the astronomers are almost completely baffled by the quasars. There is no better fundamental understanding of the quasars now than there was when they were first discovered, twenty years ago. There has been a great deal of empirical information gathered, but there is no understanding of that information. The general tendency in astronomical circles is to blame the physicists. As expressed by one prominent astronomer, Gerrit Vershuur, *"the existence of quasars strongly suggests that we are dealing with phenomena which present-day physics is at a loss to explain."* Now that's true. But the astronomers can't evade all responsibility. They did not have to accept all of these contrafactual assumptions that the physicists have made.

When the first pulsar was discovered, the regularity of the pulses suggested that they might be artificially created, and for a time it was fashionable to refer to them as messages from little green men. When more pulsars were found, it was realized that the pulsars must be natural objects, and the little green men were dropped. That may have been a mistake. This universe that the astronomers have worked so hard to construct is not of much use to us except for entertainment, because we are so constituted that we cannot deal physically with things that are not physical. We have to have things which, as Heisenberg says, exist in the same sense that trees and stones exist. But this universe that they have built would be a very appropriate home for the little green men, perhaps even degenerate little green men.

An Outline of the Deductive Development of the Theory of the Universe of Motion

Preface

Ever since the dawn of science, the ultimate objective of the theoreticians in the scientific field has been to devise a *general* physical theory: one in which all physical phenomena are derived from a single set of premises. As expressed by Richard Schlegel of Michigan State University:

In a significant sense, the ideal of science is a single set of principles, or perhaps a set of mathematical equations, from which all the vast process and structure of nature could be deduced.

Up to the present time, all of the many efforts along this line have been fruitless. It has not even been possible to derive the relations in *one* major physical field from general premises; that is, without making assumptions specifically applicable to that particular field and to that field only. But, the development of the Reciprocal System of theory has now produced just the kind of a thing that Dr. Schlegel describes: a set of basic postulates whose necessary consequences are sufficient in themselves to describe a complete, theoretical universe.

More than 90% of the conclusions derived from these postulates are in agreement with concurrent scientific thought, and are not contested. Thus, the Reciprocal is not only a general physical theory; it is a general physical theory that, on the basis of present knowledge, is at least 90% correct. It therefore constitutes a significant advance in scientific understanding, irrespective of the judgment that may ultimately be passed upon the remaining 10% of the conclusions derived from the theory.

Under the circumstances, many individuals are interested in making a critical examination of the development of thought from the fundamental postulates to the various conclusions in order to satisfy themselves that this development is, in fact, purely deductive. This present work has been designed to facilitate such an examination. In the previous publications which introduced the new theoretical system it was, of course, necessary to devote much of the text to explanation and argument, and even though these works have emphasized the fact that all of the conclusions reached in the theoretical development are derived solely from a determination of the consequences of the postulates, many readers have been unable to follow all of the logical development of the various lines of thought. It is probably that this is due, at least in large part, to a tendency to expect something of a more esoteric nature—some magic formula or all-embracing mathematical expression—rather than the simple “if this, then that” type of deductive developmenet by which the theoretical structure has been constructed. In any event, it has seemed advisable to supplement these previous publications with a presentation which will cover the basic portions of the new system of theory without explanation or argument, and will concentrate entirely on a step-by-step derivation of the pertinent points.

This presentation as it now stands (subject to possible extension later) is essentially no more than a sample; it carries the development of theory forward only a few steps. But even this very modest start toward a determination of the consequences of the postulates already brings us to the point where some of the most important features of the physical universe have been duplicated by the theoretical features that have emerged. Already, in this very early stage of the theoretical development, we find that the universe defined by the theory is expanding (as the observed universe does). It contains radiation, consisting of individual particles (photons) which travel outward at unit speed (the speed of light) in all directions from various points of emission, followed a wave-like path (in full agreement with the properties of radiation as observed.) The speed of light, and of radiation in general, in this universe is constant, irrespective of the reference system (as it is in the observed universe).

The theoretical universe contains matter, consisting of individual atoms (as the observed universe does). This matter is subject to gravitation, which acts instantaneously, without an intervening medium, and in such a manner that it cannot be screened off or modified in any way (just as gravitation does in the observed universe, although most theorists close their eyes to these facts because they cannot account for them). In this theoretical universe, there are a specific number of different kinds of atoms with different properties; the chemical elements (as in the observed universe). These elements constitute a series, each member of which differs from its predecessor by one unit of a particular kind, and the series is divided into groups and sub-groups with certain group characteristics (all of which is in full agreement with observation). There are additional types of units similar to, but less complex than, the atoms, which have some, but not all, of the properties of the atoms (also in agreement with the *observed* properties that are currently *assumed* to exist).

In the light of this demonstration of how the major features of a theoretical counterpart of the observed physical universe—radiation, matter, gravitation, the galactic recession, atomic structure, *etc.*—can be derived by a relatively simple logical development of the conclusions that are implicit in the postulates of the theory, it should not be difficult to understand how the theoetical universe can be extended into great detail by further application of the same process of following out the logical implications of the postulates and the conclusions previously derived. Furthermore, it is clear, even at this very early stage of the investigation, that this development is capable of resolving some of the most serious issues facing current science.

The manner in which the development of the theoretical structure leads to a unique set of numerical values for each chemical element—a series number, and three rotational displacement values—also shows how the mathematical character of the theoretical universe emerges side by side with the qualitative relationships. Obviously, these sets of numbers are the means by which the elements enter into the mathematical aspects of the many physical relations that appear later in the development, and the simple manner in which they are deduced from the basic premises should serve as an explanation as to why nothing of a more complex mathematical nature than simple arithmetic is needed in the early stages of the inquiry.

The fundamental postulates, together with some comments concerning the interpretation of the language in which they are expressed, are stated in Section 1. The statements that follow are sequential; that is, each is a necessary consequence of the statements that have preceded it, either in the postulates themselves, or in previous deductions from the postulates. The justification for asserting that each specific conclusion is a necessary consequence of something that preceded this may not always be obvious, but the objective of the present work is to identify the specific items entering into the system of deductions leading from the postulates to the various theoretical conclusions, and to show how each fits into the deductive pattern. Everything which might tend to divert attention from this objective, such as explanation or argument, has therefore been omitted. In any case where the continuity of thought may not be clear reference should be made to previous publications describing the theory.

1. The Basic Relations

Conceptual Fundamentals

This theory introduces two new concepts into physical science: the concept of *physical location*, and the concept of *scalar motion*.

The nature of these new concepts can be illustrated by a consideration of the "expansion of the universe" that is postulated in the astronomers' latest theory of the recession of the distant galaxies. As explained by Paul Davies, "The expanding universe is not the motion of the galaxies *through* space... but is the steady expansion of space." Since the galaxies, on this basis, are not moving through space, each galaxy remains in what we will call a physical location in space. This physical location is moving outward in the context of the stationary spatial reference system, carrying the galaxy with it. While only the galactic motion can be observed, all physical locations necessarily participate in the outward motion, irrespective of whether or not they are occupied by galaxies.

Inasmuch as all galaxies, and the physical locations that they occupy, are moving uniformly outward from all others, each is moving outward in all directions. A motion distributed uniformly over all directions has no specific, or inherent, direction; that is, it is scalar. Thus the expansion can be described as a positive scalar motion of all physical locations (represented as outward in the spatial reference system). Our new theory defines a universe of motion in which scalar motion of physical locations is not a unique phenomenon confined to the expansion recognized by the astronomers, but is the basic form of the motion from which all physical phenomena are derived.

Basic Premises

The basic premise of the theory consist of certain preliminary assumptions, a postulate, and a definition.

A. In order to make science possible, some preliminary assumptions of a philosophical nature must be made. We assume that the universe is rational, that the same physical laws apply throughout the universe, that the results of experiments are reproducible, etc. These assumptions are accepted by scientists as a condition of becoming scientists, and are not usually mentioned in purely scientific discourse.

B. We assume that the generally accepted principles of mathematics, to the extent that they will be used in this development, are valid.

C. We postulate that the universe is composed entirely of one component, motion, existing in three dimensions and in discrete units.

D. We define motion as the relation between two uniformly progressing reciprocal quantities, space and time.

Deductive Development

Each of the following statements is a deduction from the postulate and the preceding statements. The objective of the deductive development is to determine what can exist in the theoretical universe defined by the premises of the theory. In most cases it will be evident that the entity or phenomenon that theoretically *can* exist is identical with one that *does* exist in the actual physical universe, and there are no definite conflicts in any case. To the extent that the outline has been carried, the theoretical universe is thus a correct representation of the observed physical universe.

1. Motion, as defined, is measured in terms of speed, the scalar magnitude of the relation between space and time.

2. By reason of the postulated reciprocal relation between space and time, each individual unit of motion is a relation between one unit of space and one unit of time, a motion at unit speed.

3. We define the *primary motions* as those which can exist independently of the existence of motions of other types.

4. According to our definition, motion involves a uniform *progression* of both space and time. We define a point, or segment, on the line of the space progression *at a given time* as a physical location in space.

5. Inasmuch as we postulate that the universe is three-dimensional, we may represent the scalar progression of space by a line in a stationary three-dimensional spatial reference system, measuring the corresponding progression in time by means of a scalar device, a *clock*. In this reference system, a positive motion is represented as *outward* from a reference point, and a negative motion as *inward*. The terms outward and inward will be used in preference to “positive” and “negative to avoid possible confusion with another use of the latter set of terms.

6. The initial point of the progression of an individual unit of motion is zero. As the

distance between two points cannot be less than zero, it follows that the primary motions are necessarily outward, increasing the distances relative to the initial points.

7. This progression is scalar. It is simply outward without any inherent direction. Motion outward from the initial point of the progression is therefore outward from all points of reference.

8. From the foregoing, any two physical locations are progressing outward from each other at unit speed; that is, their separation is increasing at the rate of one unit of space per unit of time.

9. We define the *natural system of reference* as that system in which the primary motions do not cause any change in the positions of physical locations.

10. From (8) it follows that the natural system of reference is progressing outward at unit speed relative to the spatial system of reference.

11. We identify unit speed as the *speed of light*.

(The various features of the theoretical universe emerge from the deductive development without labels. It is therefore necessary to identify the physical phenomena to which they correspond. The correlation is usually quite evident, as in this instance. In any event, it is self-verifying, as any error would quickly show up in the subsequent development.)

12. Since the postulate specifies that nothing exists other than discrete units of motion, and the natural reference system is a direct consequence of the existence of the primary units, this reference system is the framework, or background, of the universe of motion, and does not represent any activity *in* that universe. The natural system of reference, as defined, is therefore the physical zero, or datum level, from which all physical activity extend.

13. We identify the outward progression of the natural reference system relative to the stationary system of reference as the “expansion of the universe” reported by the astronomers.

At this point we have arrived, by deduction from our basic premises, at an explanation of the general background of the physical universe that is essentially in agreement with the astronomers’ *assumption*. (Our derivation leads to a uniform outward speed, rather than a speed that varies with the distance, as produced by the kind of an expansion assumed by the astronomers, but this difference is easily accounted for, because there is a known force, gravitation, that acts against the outward motion, with a magnitude varying as an inverse function of distance.)

The advantage of deriving this explanation of the universal background from a set of general premises, rather than merely assuming its existence, lies in the fact that further deductions can be made from these same premises. Instead of a single process involving the universe as a whole, the explanation that we have just derived from the premises of the theory of the universe of motion identifies the expansion as the result of outward scalar motions of individual physical locations. This opens the way for the existence of other scalar motions of the same physical locations, *independent motions*, as we will call them.

14. Once the primary units of motion are in existence, units of inward scalar motion can be superimposed on the outward units. The net magnitude of the two motions is zero, and the combination therefore has no physical properties in a spatial reference system, but it constitutes a base upon which other combinations can be formed.

15. As stated in our definition, motion is a progression. Thus it is not a succession of jumps, even though it exists only in discrete units. There is progression within the unit, as well as unit by unit, simply because the unit is a unit of motion (progression). The significance of the discrete unit postulate is that discontinuity can occur only between units, not within a unit. But the various stages of the progression within a unit can be *identified*.

16. The continuity of the progression within the units enables the existence of another type of scalar motion of physical locations. This is a motion in which there is a continuous and uniform change from outward to inward and vice versa; that is, a *simple harmonic motion*. At this stage of the development only continuous processes are possible, but a continuous change from outward to inward and the inverse is just as permanent as a continuous outward or inward motion.

17. In the two-unit complete cycle of the simple harmonic motion the net change of the spatial position of the physical location is zero. As represented in the spatial reference system, the two-unit combination remains stationary in the dimension of motion.

18. From (10) it follows that the physical location occupied by that motion combination (17) moves outward at the speed of light in a second dimension.

19. The path of the combined progressions then takes the form of a sine curve.

20. We identify such scalar motion combinations as *photons*. A system of photons is *electromagnetic radiation*.

(This derivation shows why radiation has the properties of a wave as well as those of particles. It is composed of particles (discrete units), but the motion (progression) of these particles is wave-like.)

21. The outward movement of physical locations due to the motion of the natural reference system relative to the stationary spatial system carries with it not only the photons, but also any other physical entities that occupy such locations.

(In addition to the photons, there are certain other massless particles that have no known motion-producing mechanism, and must therefore remain stationary in the natural system of reference, unless acted upon by some outside agency. There are also objects—very distant galaxies—that do have a motion-producing mechanism (gravitation), but are so far away that the gravitational motion toward our location has been reduced to negligible levels. All of these objects behave exactly as required by the theory; that is, they move outward relative to the spatial reference system at the speed of light.)

22. There is no inherent relation between the time magnitudes involved in the different dimensions of the photon motion. One is the time of the progression of the natural reference system. The other is independent of this progression. Thus the *frequency* of the

radiation, the number of cycles per unit of the linear progression, can take any value, subject only to the capability of the process whereby the radiation is produced.

23. The postulate that the universe is three-dimensional means that three independent magnitudes are required for a complete definition of each of its basic quantities. Thus three dimensions of scalar motion are possible. In order to distinguish these purely mathematical dimensions of motion from the dimensions of *space,* which are geometrical, as well as mathematical, in the context of a spatial reference system, we will refer to them as *scalar dimensions.*

24. Only one dimension of motion can be represented in a three-dimensional spatial system of reference. Each motion shown in such a system is represented by a vector, a one-dimensional quantity having both magnitude and direction, and any combinations of such motions can be represented by the vector sum, which is likewise one-dimensional.

25. A scalar motion has magnitude only, and no inherent spatial direction. It therefore has to be given a direction in order to be represented in a spatial reference system.

26. To give directions to the members of a system of scalar motions, it is necessary to couple one of the moving locations to the stationary reference system in such a way that it is represented as motionless. The directions imputed to the other motions of the system are then determined by their relation to this assumed motionless *reference point.*

(For example, if we designate our galaxy as A, the direction of the motion of distant galaxy X, as we see it, is AX. But observers in galaxy B see galaxy X as moving in a very different direction BX because they use a different reference point. This contrasts sharply with the directions of the motions of our ordinary experience—vectorial motions—which are the same regardless of the location from which they are being observed. In this vectorial case the direction is the property of the motion.)

27. From (25) and (26), it follows that the factors which determine the direction of a scalar motion are independent of those which determine the magnitude. The direction is a result of the nature and location of the coupling of the motion to the reference system. It may be a *constant* direction, as in the outward travel of the photons of radiation, or it may be a *rotationally distributed* direction, one that is continually changing.

28. From (27), the translational motion of a photon, instead of being unidirectional, as in (18), may be rotationally distributed in the reference system. The motion thus distributed, which we will call a *scalar rotation,* is a linear progression with a constant magnitude but a continually changing direction.

29. From (23), scalar rotation can take place coincidentally in three dimensions. From (24), however, it can be represented in a spatial reference system only on a one-dimensional basis. The magnitudes of the motions in the three dimensions are additive, and can be represented as a total, but the directions of the different distributions cannot be combined. The representation in the reference system therefore indicates the correct magnitude (speed) of the three-dimensional motion, but shows only the directions applicable to the single dimension of the motion that is parallel to the dimension of the reference system.

30. In the absence of any specific restrictive factor, rotationally distributed scalar motions are distributed over all spatial directions. The magnitude of such a motion toward a point in any given direction is therefore inversely proportional to the second power of the intervening distance.

(This is the origin of the “inverse square law.”)

31. Inasmuch as the natural reference system progresses outward at unit speed relative to the spatial reference system, no further increment of outward speed is possible, because of the discrete unit postulate. The net total magnitude of a rotationally distributed linear motion must therefore be inward.

32. If the scalar motion is less than three-dimensional, the basic photon will move outward as radiation in a vacant dimension, and the motion combination will disintegrate. In order to be stable, the rotationally distributed motion must therefore be three-dimensional.

33. The three-dimensional combination of vibrational and rotationally distributed motions appears in the reference system as an identifiable object moving inward in all directions. We identify such an object as an *atom*, or a *sub-atomic particle*. Collectively, the atoms and particles constitute *matter*.

34. We identify *mass* as a measure of the net magnitude of the rotationally distributed scalar motions of matter. We identify the observable inward-directed effects of this motion as *gravitation*. The magnitude of the gravitational effect is therefore directly proportional to the mass.

35. The inward gravitational motion of the atoms results in the formation of material aggregates of various sizes. In these aggregates the atomic motions (and masses) are independent and additive.

36. The outward motion due to the progression of the natural reference system always takes place at unit speed, regardless of the size of the aggregate or the distance that is involved (8). The *net* relative motion of any two gravitating objects with no additional motions is the algebraic sum of the unit outward motion and the inward gravitational motion.

Because of the spherical distribution of the gravitational motion in the reference system, the magnitude of the motion of one unit of matter toward another is inversely proportional to the square of the intervening distance.

37. At relatively short distances gravitation predominates, and the net motion is inward. Since the gravitational motion decreases with distance, while the outward progression remains constant, the opposing motions reach equality at some greater distance, which we will call the gravitational limit. Beyond this distance the net motion is outward, increasing with distance, and approaching unity (the speed of light) at extreme distances.

(This theoretical pattern of net speeds is verified observationally by measurements of the Doppler shift in the radiation received from the distant galaxies.)

38. The conventional spatial reference system in conjunction with a clock for measuring

time represents a physical situation in which the space component of the progression of the natural reference system is neutralized by gravitation, while the time component progresses at the full normal rate. In this reference system, the space progression, as indicated by the motion of a massless object, appears as a one-dimensional motion through three-dimensional space.

39. Since we postulate a reciprocal relation between space and time, each of the deductions expressed in the foregoing numbered statements is also valid in the inverse form; that is, with space and time interchanged.

40. We identify the time component of the progression of the natural reference system as the “flow of time” registered on a clock.

41. It follows from (39) that motion in time takes place in three dimensions, in the same manner as motion in space. The time component of the progression of the natural reference system (clock time) is a one-dimensional outward motion through a stationary three-dimensional temporal system of reference, in which independent motions at different speeds and different directions also take place.

42. Motion at unit speed causes unit change of position in both the spatial reference system and the temporal reference system. It is a *motion in time* as well as a motion in space.

43. When motion takes place in time, the constant progression analogous to clock time is in space, and would be measured by some kind of a “space clock.” But the rates of progression are the same, one unit of space and one unit of time per unit of motion. Thus the measurements relative to the “space clock” are identical with those relative to a clock that registers time, if expressed in the same units.

44. As noted in (2), the space-time ratio in the units of motion is fixed at unity by the reciprocal postulate. It follows that a reduction of speed—as, for instance, by an increase in the distance between gravitating objects—does not alter the ratio of space to time in the effective motion; it reduces the proportion of the total motion that is effective in increasing the spatial separation of the objects. This effective portion of the motion increases the separation by x units of space per one unit of clock time, where x is a fraction, and because of the fixed relation between space and time in the individual units, also increases the separation in time by x units.

45. Where only one motion is involved, the x units of time are coincident with the time progression, and do not enter separately into the determination of the speed. But if two objects are both moving, their relative position in space may change at a rate exceeding unity by some quantity x. From (44), the change in the separation in time then also exceeds unity (clock time) by x. The speed is $(1+x)/(1+x)=1$. Thus, if at least one of the two objects is a photon (or other object moving with unit speed), the relative speed is always unity. This agrees with statement (8).

(This is the explanation of the observed fact that the speed of light is independent of the reference system.)

46. Where motion at a speed greater than unity (motion in time) takes place under

conditions that preclude actual changes of position in time, this motion acts as a modifier of the spatial motion; that is, a motion in *equivalent space*. The spatial equivalent of a temporal magnitude x is $^{1}/_{x}$.

47. Where scalar motion in space is three-dimensional, the speed in one of the dimensions may be greater than unity. But, as indicated in (29), the effective magnitude of a combination of motions is determined by the net total of the scalar speeds, and because there are two low speed dimensions, the net speed is less than unity. In this case, then, the motion in the high speed dimension acts as a motion in equivalent space, and modifies the magnitude of the change of position in space, rather than causing a change of position in time.

48. We identify the material atoms with scalar rotation in equivalent space as the atoms of the electronegative elements.

49. We also encounter motion in equivalent space within the units of space. Here no modification of the normal progression of space can take place (because of the discrete unit postulate), but motion can take place in time. Inasmuch as this motion within the spatial unit does not alter the position in time of the unit as a whole, the changes within the unit that result from the motion are observed in equivalent space rather than in actual time.

50. The existence of a spatial unit within which motion has properties quite different from those prevailing in the region outside the unit explains the discontinuity in physical properties at very short distances that has led to the development of the quantum theory.

51. The progression of the natural reference system relative to the spatial system of reference is always outward, but, as indicated in (10), the natural datum level, or physical zero, is at unity, rather than at the mathematical zero. Within a unit of space, outward from unity is toward zero. It follows that the progression within the unit, as seen in the spatial reference system, is inward.

52. From (31), the gravitational motion is inward. This direction, too, is inward relative to the natural datum, unity. Within a unit of space, it is therefore outward in the spatial reference system.

53. No stable equilibrium between the atoms or aggregates of matter is possible at separations greater than one unit of space. The inward and outward motions are equal at the gravitational limit, but this equilibrium is unstable, as the change in separation due to any unbalance between the opposing motions increases the unbalance. Within a unit of space, where the directions of the basic motions as seen in the spatial reference system, are reversed, the effect of a change in separation between atoms due to an unbalance of the opposing motions reduces the unbalance, and eventually results in the establishment of a stable equilibrium.

54. The positional equilibrium in equivalent space that is established within a unit of space accounts for the existence of the crystalline state of matter.

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2. Atoms

In the first section of this outline, the general characteristics of the motion of which the universe is constructed, together with additional information about the various forms and manifestations of that motion, were deduced from the postulates of the theory. With the benefit of this information we are now in a position to develop the details of the individual phenomena in the various physical fields. We will begin by identifying the possible combinations of scalar rotations (atoms and sub-atomic particles) and their individual characteristics, including the properties that are represented in the periodic table of the elements. As in Section I, each statement is a deduction from the postulates of the theory or from one or more of the numbered statements earlier in the outline.

55. As noted in (12), the primary motions are the framework, or background, of the universe of motion, and do not constitute any physical activity in that universe. Physical activity—that is, meaningful change—in the physical universe results from motions superimposed on the primary motions. We will now want to examine the general considerations involved in such *combinations* of motions. First we note that there are no restrictions on the combination of motions of the same kind in different dimensions. For instance, rotations in different scalar dimensions can combine by rotating around the same central point.

56. The normal progression, both of the natural reference system and of the added motions, is a continuous *succession* (rather than a combination) of units of the same kind. As soon as one unit of the progression ends, another one begins. But the units in a succession do not necessarily have to be identical. For example, the two-unit cycle of simple harmonic motion has the same initial and final points as a two-unit segment of unidirectional linear motion, and therefore fits into the linear progression. We may generalize this situation, and say that *compatible* units of a different kind of motion can replace units in the normal progression.

57. It follows from (44) and (56) that compatible units of motion added in a dimension of an existing motion will merge with this previously existing motion, merely altering its magnitude. Formation of a *compound motion*, a combination that retains the distinction between its components, therefore requires the addition of an incompatible motion.

58. Except where outside forces intervene, the added motion must oppose the original in order to achieve stability. Otherwise there is nothing to hold the components together. The opposition reduces the net total magnitude of the motion, and since lower numbers are more probable than higher numbers, this makes the combination more probable than independent existence of the components.

59. A numerical constraint on the combinations is imposed by the discrete unit postulate. Addition of two inward units of motion to the unit outward progression of the natural reference system produces one net inward unit, the limiting value. The maximum linear addition to a motion combination is thus two units.

60. Where the motion is n-dimensional, the maximum is two units in each dimension, a

total of 2^n units.

61. Scalar motion is measured in terms of *speed* (or inverse speed). As we have seen, however, the natural datum level is at unity, not at zero. The natural speed magnitudes are therefore the deviations from unity. A deviation downward from unity, $^1/_1$ to $^1/_n$, has the same natural magnitude, n-1 units, as a deviation upward from $^1/_1$ to $^n/_1$. In dealing with the basic scalar motions we will therefore use the deviations rather than the speeds measured from zero. We will call these deviations “speed displacements,” abbreviated to “displacements” where the meaning is clear.

62. Where quantities are reciprocally related, the choice as to which should be called “positive” is purely arbitrary. It will, however, be convenient to refer to the phenomena of our ordinary experience as positive. Since the speeds in our local environment are below unity, we will call a decrease in speed from $^1/_m$ to $^1/_n$ a *positive* displacement of n-m units, and an increase in speed from $^m/_1$ to $^n/_1$ a *negative* displacement of n-m units.

63. The photon, as defined in (20), is a vibrating unit that moves outward translationally at the speed of light. As noted in (22), the frequency of the vibration is limited only by the capacity of the production process. The atom, defined in (33) is likewise a vibrating unit with an added linear (scalar) motion, but in this case the linear motion is rotationally distributed over all directions, and the rotational character of the added motion imposes some restrictions on the numerical magnitudes.

64. A one-dimensional scalar rotation (28) of the linear vibrational unit generates a two-dimensional figure, a disk. A scalar rotation of the disk around another axis generates a three-dimensional figure, a sphere. This exhausts the available dimensions. The basic scalar rotation of the atom is therefore two-dimensional.

65. While no further rotation of the same kind (inward) is possible, the entire combination of motions can be given an *outward* scalar rotation around the third axis. This conforms to the requirements of (57)—it is a one-dimensional addition to a two-dimensional motion—and those of (58)—it is an outward motion added to an inward motion.

66. The vibrational speed displacement of the basic photon may be either positive (less than unity) or negative (greater than unity). For the present, we will consider only those combinations in which the basic vibrational displacement is negative. We will call this system of combinations the *material* system. The system based on the positive photon speed will be called the *cosmic* system.

67. From (58) we find that where the vibrational displacement is negative the net total rotational displacement must be positive.

68. Where a one-unit positive rotational displacement is applied to a one-unit negative vibration, the net total speed displacement (a scalar quantity) is zero. This combination of motions has no effective deviation from unit speed (the physical datum), and therefore has no observed physical properties. We will call it the *rotational base* of the material system. A similar combination with positive vibration and negative rotation is the rotational base of the cosmic system.

69. For convenience, we will represent the different motion combinations of this type of sets of numbers representing the speed displacements in the three scalar dimensions. We will specify only the *effective* magnitudes of the displacements, and we will use the letters M and C to indicate whether the combination belongs to the material or the cosmic system. The displacement magnitudes will be expressed in the form M a-b-c, where a and b are the effective displacements of the two-dimensional rotation, which we will call the *magnetic* rotation, and c is the effective displacement of the one-dimensional, or *electric*, rotation. Negative displacements will be enclosed in parentheses. On this basis, the material rotational base is M 0-0-0, and the cosmic rotational base is C 0-0-0.

70. To the material rotational base we may add a unit of positive electric rotational displacement (that is, one unit of effective one-dimensional scalar rotation), producing M 0-0-1, which we identify as the *positron*. Or we may add a unit of negative electric displacement, producing M 0-0-(1), which we identify as the *electron*. These are the first members of a series of combinations that we identify as the *sub-atomic particles* of the material system.

71. Addition of a magnetic (two-dimensional) displacement unit to the material rotational base produces M ½-½-0. There are no half units, but a magnetic unit occupies both dimensions, and we therefore credit half to each. We identify this combination as the *muon neutrino*.

72. At the unit level, the magnetic and electric displacement units are numerically equal; that is, $1^2 = 1$. Addition of a unit of negative electric displacement to the muon neutrino therefore produces a combination with a net total rotational displacement of zero. We identify this combination, M ½-½-(1), as the *electron neutrino* (hereinafter referred to simply as the *neutrino*).

73. Geometrical considerations indicate that two photons—in different scalar dimensions—can rotate around the same central point without interference as long as the rotational speeds are the same, thus forming a double structure. Any rotational combination with two or more net units of rotational displacement can take the double structure.

74. This introduces a new situation: the existence of competing structures. The aim of our development of the consequences of the postulates of the theory of the universe of motion is to determine what *can* exist in that theoretical universe. Thus far we have been able to identify an existing feature of the observed physical universe corresponding to each of the entities and phenomena that we have found that can exist in the theoretical universe. From now on we will have to consider the possibility that the existence of certain structures may preclude the existence of competing structures. The result of the competition in each case is a matter of relative probability. Where the probabilities are nearly equal, the structures may coexist. Otherwise, the structure that is most probable (in a given set of circumstances), is the only one that exists under those circumstances, other than momentarily.

75. The double rotational structure is more compact, and therefore more resistant to disruption than the equivalent single structures. This gives it a sufficient margin of

probability to preclude the existence of any significant quantity of the competing single structures (unless external forces intervene).

76. We identify the double rotational combinations as *atoms*.

77. The combination ½-½-1 has a total net rotational displacement of 2, and is excluded by (75). The two-unit magnetic structure M 1-1-0, and its positive derivative M 1-1-1, which have net displacements of 2 and 3 respectively, are likewise excluded for the same reason. But the negative derivative M 1-1-(1) can exist as a particle, since its net displacement is only one unit. We identify it as the *proton*.

78. A double rotating system with only one net unit of displacement can be formed by a combination of a rotation of the proton type, M 1-1-(1), and a rotation of the neutrino type, M ½-½-(1). We identify this combination, M 1½-1½-(2), as the mass 1 isotope of *hydrogen*. Since the second rotation has a net displacement of zero, the probability difference between this double structure and the equivalent single structure, the proton, is small. These structures therefore coexist under appropriate conditions.

79. If the cosmic neutrino type of rotation, C (½)-(½)-1 is substituted for the material neutrino type of rotation in this double structure, the combination has net total displacements of M ½-½-0. We identify it as the *neutron*.

80. Because of some significant differences between atoms and sub-atomic particles, we will use a different system of notation in representing the atomic combinations. This notation will show the *total* speed displacement in each dimension (including the initial non-effective unit), will use a double unit, and will omit the letter symbols M and C, which are unnecessary when the initial unit is included.

81. To convert the rotational displacement of the mass 1 hydrogen atom from the sub-atomic notation, M 1½-1½-(2), to the atomic notation, we divide by 2, obtaining 1-½-(1), and then add the initial unit, the result being 1½-1-(1). The net effective displacement, in terms of the double unit is ½.

82. An additional single unit of displacement brings the total to 2-1-(1). We identify this combination as the mass 2 isotope of hydrogen. This is the first of the complete two-rotation combinations (those with effective rotational displacement in both rotations). It is therefore given the *atomic number* 1.

83. One positive displacement unit (atomic basis) added to mass 2 hydrogen, 2-1-(1), neutralizes the negative electric rotation, and produces 2-1-0. We identify this combination as *helium*, atomic number 2.

84. Successive additions of units of positive electric displacement, or the equivalent, to the helium atom, produce the other members of a series of atomic combinations, the series of *chemical elements*.

85. Inasmuch as the two-dimensional (magnetic) rotation is the basic rotation of the atom, as indicated in (64), the magnetic rotation takes precedence over the electric rotation where

both are possible. It follows that some of the additions to the atomic series involve magnetic displacement in lieu of electric displacement. If we let n represent the number of double magnetic units of displacement (units of atomic number), the corresponding number of single magnetic units is 2n. When acting jointly in a motion combination, x magnetic units are equivalent to x^2 one-dimensional (electric) units. The 2n single magnetic units are therefore equivalent to $4n^2$ single electric units. Dividing by 2 to convert the double units of the atomic system, we find that n magnetic displacement units in an atom are equivalent to $2n^2$ electric displacement units.

86. Successive additions of magnetic displacement go alternately to the two magnetic dimensions, since small numbers are more probable than larger numbers. One magnetic unit added to helium, 2-1-0, produces 2-2-0, which we identify as *neon*.

87. Helium already has one effective magnetic displacement unit in each magnetic dimension. Thus the increase from 2-2-0 involves a second unit in one of the dimensions. From (85), this second magnetic unit is equivalent to $2 \times 2^2 = 8$ electric units. It should be noted that this is the electric equivalent of the *second* unit, not the sum of the two units. The reason is that the progression in the region inside unit space takes place in time only, and the succession of values is $^1/_1$, $^1/_2$, $^1/_3$, $^1/_n$. The number of time units involved is 1,2,3,...n. Thus the value 2 applies to the second unit only, not to the total of the first two units.

88. The first four additions of electric displacement units to helium produce the following series of elements:

Number	Displacements	Element
3	2-1-1	Lithium
4	2-1-2	Beryllium
5	2-1-3	Boron
6	2-1-4	Carbon

89. As long as the magnetic displacement—the major component of the atomic rotation—is positive, the electric displacement—the minor component—can be negative without violating the requirement (67) that the net total rotational displacement of a material atom must be positive. Carbon can therefore exist with the alternate displacements of 2-2-(4). Here the Neon type magnetic rotation with net displacement 10 is combined with 4 negative electric displacement units, for a net positive total of 6, the same as the net displacement of the 2-1-4 combination. The probability difference between these two combinations is small, and both are found observationally. Beyond Carbon the probabilities favor the smaller negative electric displacement. The normal forms of the next three elements are therefore:

Number	Displacements	Element
7	2-2-(3)	Nitrogen
8	2-2-(2)	Oxygen
9	2-2-(1)	Fluorine

90. Another group of eight elements follows, bringing the second magnetic dimension up to two effective displacement units at Argon, 3-2-0. A further one-unit increase raises the effective displacement level to 3 units in one of the magnetic dimensions. The third magnetic unit is equivalent to $2 \times 3^2 = 18$ electric units. Two 18-unit groups of elements therefore follow, increasing the displacements first to 3-3-0 (Krypton, element 36) and then to 4-3-0 (Xenon, element 54). Finally, there are two groups of $2 \times 4^2 = 32$ elements each. The first of these carries the series of 4-4-0 (Radon, element 86). The second would reach 5-4-0 (element 118), but here another factor intervenes.

91. From (60), the maximum three-dimensional scalar rotation has a magnitude of eight units. The significance of this is that at a speed displacement of eight net units, the rotationally distributed progression reaches the same scalar location, the end of the spatial unit, that a linear progression reaches in the same time interval. The next unit of the progression then begins without any limitation on the nature of the coupling to the reference system. In the absence of such a limitation, the motion takes the most probable form, a unidirectional linear progression. This means that at element 118, where the rotational displacements are 5-4-0, and there are a total of eight effective magnetic displacement units (four in each dimension), the rotational combination of motions disintegrates and reverts to the linear basis. The series of chemical elements therefore terminates at element 117.

92. Because the succession of speed displacements follows the definite pattern outlined in (84) to (91), each element can be characterized by a unique set of numbers (subject to some modification under special circumstances). These are the values that enter into the various equations which determine the magnitudes of the different properties of the elements and their combinations.

93. Each successive element in the atomic series adds one double unit of positive three-dimensional rotational speed displacement to the combination of motions (the atom). In (34), three-dimensional speed displacement, positive in the material system, was identified as *mass*. The atomic mass is expressed in terms of *atomic weight*, the unit of which is half the rotational mass corresponding to the atomic number. The *rotational mass* of an atom of atomic number n is thus 2n atomic weight units.

94. When physical quantities are resolved into component quantities of a fundamental nature, these component quantities are called "dimensions." Since we postulate that the physical universe is composed entirely of units of motion, a relation between space and time, the dimensions of all physical quantities (in this sense of the the term) can be expressed in terms of space and time only. From (34), the three-dimensional gravitational motion of the atoms of matter has the dimensions s^3/t^3, where s and t are space and time, respectively.

95. In order to change the spatial position of an atom, or an aggregate of atoms, an outward motion must be applied against the inward scalar motion of the atom. That inherent inward motion then acts as a resistance to the applied outward motion. In this capacity as a resistance, or *inertia*, the mass acts as the inverse of a three-dimensional speed, with the dimensions t^3/s^3. In practice, gravitation is measured in terms of force, a derivative of

inertia, rather than in terms of speed. Both the gravitational and the inertial relations are therefore expressed in terms of the t^3/s^3 magnitudes.

(This explains why measurements of the "gravitational mass" and the "inertial mass" arrive at the same result.)

96. Having established the space-time dimensions of mass, we can now define the dimensions of the other physical quantities of the mechanical system. The product of mass and speed, *momentum*, is $t^3/s^3 \times s/t = t^2/s^2$. The product of mass and the second power of speed, *energy*, is $t^3/s^3 \times s^2/t^2 = t/s$. *Acceleration*, the time rate of change of speed, is $s/t \times 1/t = s/t^2$. *Force*, the product of mass and acceleration, is $t^3/s^3 \times s/t^2 = t/s^2$.

97. Physical phenomena with the same dimensions have the same general status in physical interactions, and are interchangeable. For example, all phenomena with the dimensions t/s are equivalent to energy, and can be converted to kinetic energy by appropriate processes.

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3. Electricity and Magnetism

In this section, we examine the application of the general physical principles developed in Section One to the basic phenomena of another physical field. The field selected for examination in Section Two was chosen to show how the quantitative relations emerge easily and naturally from the mainly qualitative general principles and relations. Now in this third section, we demonstrate the ability of the theory of the universe of motion to clarify the theoretical relations in a field that has heretofore been subject to much confusion. As in the preceding sections, each statement is a deduction from the postulates of the theory or one or more of the numbered statements earlier in the outline.

98. The only difference between the effective component of the electron, M 0-0-(1), and the rotational base, M 0-0-0 (69), is one unit of rotational space displacement. It is therefore a rotational combination with the dimensions of space.

(The term "electron," as used in this outline refers to the particle defined in (70). Similar particles carrying charges will be identified as "charged electrons.")

99. As noted in (97), different physical phenomena with the same space-time dimensions have the same status in physical interactions. From the general physical standpoint, the electron is therefore equivalent to a unit of what we may call extension space, the "space" of our ordinary experience.

(The idea of the equivalent of ordinary space is new to science and may be conceptually difficult for some scientists, but it is the same kind of a concept as the idea of the equivalent of ordinary kinetic energy that we have all become accustomed to. For example, if we wish to put a rocket into orbit, what we have to do is to accelerate it to a certain speed; that is, give it a certain amount of kinetic energy. But, in addition, we must provide enough fuel energy to compensate for the difference in the energy of position—potential energy—and lift the rocket against the earth's gravity. This potential energy is not "kinetic energy," but it is "energy," and in relations involving energy in general it is the *equivalent* of kinetic energy. Similarly, electron space is not "extension space," but it is "space," and in relations involving space in general it is the equivalent of extension space.)

100. From (67), the net speed displacement of the atoms of ordinary matter is positive; that is, in terms of effective units there is an excess of time over space. The electron can therefore move through matter, as the relation of space (electrons) to time (matter) constitutes motion, according to the postulates of the theory of the universe of motion. It cannot move thru space, relative to the natural reference system, as the relation of space (electrons) to extension space does not constitute motion.

101. We identify the movement of electrons through matter as current electricity. It should be noted that the current moves through the matter, not through the spaces between the atoms, as has been assumed.

102. The movement of space (electrons) through matter is identical, except in scalar direction, with the movement of matter through extension space. Thus quantities involved in these motions, and the relations between them, are thus the same in both cases. We may characterize the relations involved in the movement of space through matter as the mechanical aspects of electricity.

103. Since the scalar direction of gravitation (a movement of matter through space) is inward (34), it follows from (102) that the scalar direction of current electricity is outward.

104. The electrons (effective dimensions s) are units of electric quantity, q. The rate at which the electrons move through matter (quantity per unit time) is the electric current, I, with dimensions s/t, equivalent to those of speed. Electrical force, or voltage, V, has the general force dimensions t/s^2. The product of voltage and current is power, P, with dimensions $t/s^2 \times s/t = 1/s$. The product of power and time is electrical energy, or work, W, dimensions $1/s \times t = t/s$. The mass taking part in the current flow is not a constant quantity, but depends on the duration of the current. The mass per unit time, dimensions $t^3/s^3 \times 1/t = t^2/s^3$, is therefore a significant quantity in current electricity. We identify it as resistance, R.

105. To demonstrate the identity of the electric current relations (motion of space through matter) with those of the mechanical system (motion of matter through space), we may compare the energy equations. Kinetic energy is $\frac{1}{2}mv^2$, space-time dimensions $t^3/s^3 \times s^2/t^2 = t/s$. Electrical energy is RtI^2, dimensions $t^2/s^3 \times t \times s^2/t^2 = t/s$. Another mechanical expression for energy is force times distance, $Fs = t/s^2 \times s = t/s$. The analogous electrical expression is voltage times electrical quantity, $Vq = t/s^2 \times s = t/s$. In both cases the equations are identical, except for the terminology.

106. Since they are phenomena of the same kind, the flow of electrons through a conductor is analogous to the flow of gas molecules through a pipeline. A constant force (voltage) differential causes a steady flow of current.

(This agrees with observation. Existing theory ascribes the flow to a difference in electrostatic potential, which it does not distinguish from voltage. But such a potential difference applied to the charged electron which is assumed to be the moving entity would result in an accelerated motion. Present-day science has no explanation for this contradiction.)

107. From (33), the scalar motion that constitutes the atom of matter is three-dimensional

and inward. The one-dimensional outward movement of electrons (units of space) through matter, or through a gravitational field, therefore neutralizes a portion of the gravitational motion and leaves a scalar motion remnant in two dimensions. The physical effects of this residual motion are known as *electromagnetism*. As would be expected, they are similar to those of gravitation, except for the differences introduced by the two-dimensionality.

108. The residual motion in two dimensions is perpendicular to the dimension of the motion that is neutralized; that is, perpendicular to the electric current.

(This provides the explanation of the unique direction of electromagnetism that has heretofore been an unexplained anomaly).

109. As the residue of the inward gravitational motion, the electromagnetic motion is necessarily inward. However, the orientation of the scalar direction “inward” with respect to the spatial reference system is reversed when the direction of the current is reversed.

(Conductors carrying current in the same direction move toward each other, while conductors carrying currents in opposite directions move away from each other.)

110. There is no two-dimensional analog of the electric current because the material system contains no negative magnetic particle. But the equivalent of a magnetic current, a two-dimensional motion through matter, can be produced by various means, such as mechanical movement of a conductor in a magnetic field. This two-dimensional motion neutralizes a portion of the three-dimensional motion of the matter, and leaves a one-dimensional residue. If a conductor is appropriately located, this residue manifests itself as an electric current. The process of producing a current by this means is known as *electromagnetic induction*.

111. As noted in (1), motion in general is measured in terms of speed. When represented in a spatial reference system, the motion acquires a direction, and speed becomes velocity. The introduction of directions does not affect the dimensional relations. All of the previous dimensional conclusions stated in terms of speed are equally valid in terms of velocity.

112. From (111) and (96), the product of mass and velocity, momentum, has the dimensions t^2/s^2. This quantity was formerly called “quantity of motion,” an expression which more clearly indicates its nature. It is actually a measure of the total motion of the mass, which consists of n mass units, each having the quantity of motion measured by the velocity. The time rate of change of velocity is acceleration. The time rate of change of the product of mass and velocity, the “quantity of motion,” is force. Thus force is, by definition, the same kind of a property of motion as acceleration. We could appropriately call it “quantity of acceleration.”

113. Since force is by *definition* (112), a property of motion, it follows that a force cannot be autonomous. The so-called “fundamental forces of nature” are necessarily properties of fundamental motions.

114. The same considerations apply to the electrostatic force, which, from (112), must also be the force aspect of an electric motion. For an understanding of this motion we return to the question as to the types of scalar motion that can exist in the theoretical universe. Thus far we have encountered three general types: 1) Unidirectional linear motion; 2)

Vibrational (simple harmonic) motion, which is linear motion with a continuous change from inward to outward, and vice versa; 3) Scalar rotation, which is a uniform rotationally distributed scalar motion.

Obviously, there is a fourth possibility, a scalar rotational vibration; that is, a rotationally distributed scalar motion with a continuous change from inward to outward and vice versa, a rotational simple harmonic motion.

115. An independent rotational vibration cannot exist, as there would be nothing to confine the progression to the rotational path, and it would revert to the more probable linear status. But a unit of rotational vibration can be combined with a unit of rotation. The inward phase of the rotational vibration is coincident with the corresponding rotation, and has no physical effect. The outward phase is an effective rotationally distributed scalar motion opposing the atomic rotation in the dimension, or dimensions, of the rotational vibration. It thus conforms to the requirement for stability, as expressed in (58).

116. From (57), the rotational vibration must not be of the same general nature as the rotation to which it is applied. The effect of this restriction is to bar three-dimensional rotational vibration. The added rotational vibrations may be either one-dimensional or two-dimensional.

117. We identify a rotational vibration as a *charge*, and a one-dimensional charge as an *electric charge*.

(Inability to identify any motion connected with the electric charge is one of the reasons why the theorists have accepted the force exerted by the charge as fundamental, even though this conflicts with the definition of force, as noted in (112). The explanation, as indicated above, is that *the charge itself is the motion*.)

118. From (115), the charge must have a carrier, an atom or particle. Independent charges do not exist.

119. From (117), the space-time dimensions of the electric charge are t/s; that is, the charge is dimensionally equivalent (97) to energy.

(The equivalence is demonstrated by the fact that charge and kinetic energy are interconvertible.)

120. Electric charges may be either positive or negative, but the total displacement is smaller, and therefore more probable, if the displacement of the charge is opposite to that of the rotation. Consequently, a positive rotation takes a negative charge, and vice versa. But in current practice the rotational combinations are designated as positive (or electropositive) if they normally take positive electric charges, and negative (or electronegative) if they normally take negative electric charges. It is not feasible to try to change this firmly established practice, so the usual terminology will be applied in the statements that follow, with the understanding that the significance appertaining to the terms “positive” and “negative” elsewhere in this outline is reversed in application to electric charge.

121. From (26), we find that in order to represent a scalar motion in a fixed spatial

reference system it is necessary to identify a *reference point*.

122. The motion of a positive charge (a high speed rotational vibration) is outward from a negative reference point toward more positive values, including the positive reference points. That of a negative charge (a low speed rotational vibration) is outward from a positive reference point toward more negative values, including the negative reference points.

(The reference system cannot distinguish between positive and negative reference points. This is another of the difficiencies of the conventional spatial reference system.)

123. From (122), two positive charges move outward from the same reference point, and therefore outward from each other (7). Two negative charges do likewise, but a positive charge moves outward from a negative reference point toward all positive reference points, including the reference point of the negative charge, and therefore *toward* the negative charge. Thus, like charges repel each other, while unlike charges attract.

124. These scalar directions of the electrostatic forces are opposite to those of the corresponding electromagnetic forces (109); that is, like electric charges repel, whereas like currents (those moving in the same vectorial direction) attract.

(This agrees with the theoretical scalar directions of these two types of motion, which are opposite. The electromagnetic motion (109) is inward, while the electrostatic motion (115) is outward.)

125 An electric charge can be applied either against the electric rotation or against one dimension of the magnetic rotation. All atoms and sub-atomic particles of the material system, except the electron, have at least one effective positive displacement unit. With the one exception, all of them can therefore take positive charges. Negative charges are confined to the sub-atomic particles with negative electric displacement, and to the electronegative elements with electric displacement of 4 or less. Those with higher displacements are usually excluded by the greater probability of positive charges based on the lower magnetic displacements.

126. Application of an electric charge to the electron neutralizes the net negative displacement of the particle. As a neutral particle, containing both positive and negative components, the charged electron is able to move either through matter (predominantly time) or through space. The charged electrons move through matter in the same manner as their uncharged counterparts; that is, they move freely through good conductors, less easily through poor conductors, and are blocked or impeded by insulators. We identify the various phenomena involved in the production and movement of these charged electrons as *static electricity*.

127. Electric charges may also be applied to atoms (existing individually or in combinations), which are then known as *ions*. As noted in (115), each unit of rotational vibration combines with a unit of rotation. The maximum degree of ionization (number of applied charges) is therefore equal to the net rotational displacement. negative ionization is confined to the most electronegative members of each rotational group, and is limited to the magnitude of the negative electric displacement of each atom. Positive ionization can

take place up to the number of net positive rotational displacement units in the atom (the atomic number). An atom in this limiting condition is said to be *completely ionized*.

128. A charge (rotational vibration) may be two-dimensional, rather than one-dimensional. In that case, it constitutes a *magnetic charge*. Material objects carrying magnetic charges are known as *magnets*. Where the charge persists for a substantial period of time, the term *permanent magnet* is applied.

129. Because of the orientation effect noted in (109) which applies to all two-dimensional scalar motion—the scalar direction (inward or outward) of the motion that constitutes the magnetic charge reverses with the direction relative to the reference system. Thus, a magnetic charge exerts an attractive force on a similar charge in one vectorial direction, and a repulsive force on one that is located in the diametrically opposite direction.

130. The force exerted by a magnet is the net total of the magnetic forces of the individual magnetic charges on the atoms. Each magnet therefore has two centers or *poles* at which the net magnetic forces in the opposite directions are at a maximum.

131. From (130) it can be seen that while a magnetically charged object has only two poles, if that object is separated into parts, each part also has two poles.

132. The existence of magnetic monopoles is excluded by (131).

(Present-day physical theory requires the existence of positive and negative monopoles analogous to positive and negative charges, and continuing attempts are being made to find such phenomena, without success.)

133. As in the case of positive and negative electric charges, and for the same reasons (123), like poles repel each other, while unlike poles attract.

134. Inasmuch as the magnetic charge is the two-dimensional analog of the one-dimensional electric charge, it has the space-time dimensions t^2/s^2. The dimensions of the quantities involved in *magnetostatics*, the phenomena of magnetic charges, are therefore related to those of the corresponding electrostatic quantities (where analogous quantities exist) by the factor t/s.

135. This relation (134) enables us to make a *positive* identification of the dimensions of the magnetostatic quantities. Magnetic charge, t^2/s^2, is not recognized under that name in current scientific thought, but an equivalent quantity, *magnetic flux*, which has these dimensions, is utilized in many of the same applications. The unit of magnetic flux in the SI system is the weber, which is equal to a volt-second, dimensions $t/s^2 \times t = t^2/s^2$. The analog of electric potential, t/s^2, is *magnetic potential*, also called *vector potential*, to distinguish it from some other quantities which have, or are thought to have, the characteristics of potential. The dimensions of magnetic potential are $t/s^2 \times t/s = t^2/s^3$.

The SI unit is the weber per meter, $t^2/s^2 \times 1/s = t^2/s^3$. Corresponding to electric field intensity, t/s^3, is *magnetic field intensity*, $t/s^3 \times t/s = t^2/s^4$. This quantity is defined as magnetic flux per unit area, on which basis the space-time dimensions are $t^2/s^2 \times 1/s = t^2/s^4$. Thus, all of these magnetic quantities have dimensions equal to the dimensions of the corresponding electric quantities multiplied by the factor t/s, as required by the theory.

136. In a number of other cases, the dimensions currently assigned to the magnetic quantities do not agree with those derived from theory in the foregoing manner. Here, the currently accepted dimensional assignments have been based on empirical observations, and the accurate dimensional analysis that is now possible shows that the observations have been improperly interpreted.

137. For example, observations show that magnetomotive force (MMF) is related to the current, I, by the expression MMF = nI, where n is the number of turns in a coil. Since n is dimensionless, this relation indicates that the dimensions of MMF are the same as those of the electric current. The unit of MMF is therefore taken as the ampere, dimensions s/t. But MMF has the characteristics of a force (as the name implies), and the dimensions should be those of magnetic potential, t^2/s^3. The dimensional study shows that the discrepancy is due to the fact that the analog of electric resistance, the *permeability*, dimensions $t/s \times t^2/s^3 = t^3/s^4$, enters into the physical relation, and this relation is actually MMF = mnI, where m is the permeability. The presence of this quantity is not detected by the usual mathematical analysis, as it takes the unit value in most magnetic applications, and has no numerical effect.

138. When the magnetic relations are corrected by introducing the permeability, and making the necessary adjustments to remove some other errors, the entire system of magnetic quantities is brought into agreement with the mechanical and electrical dimensions. This completes the identification of a comprehensive and entirely consistent system of dimensional relations covering the full range of physical phenomena.

(The demonstrated ability to express the dimensions of all physical quantities in terms of space and time is not only a powerful tool for analyzing physical relations, but also provides an impressive confirmation of the validity of the postulate that the physical universe is composed entirely of these two components.)

139. The most serious error about conventional electric and magnetic theory revealed by the dimensional analysis, is the lack of distinction between electric quantity and electric charge that has resulted from the assumption that the electric current is a movement of charges. In present-day practice, both charge and quantity are measured in the same units—coulombs in the SI system. But the interconvertibility of electric charge and kinetic energy (97) definitely shows that charge has the energy dimensions, t/s, while the relations cited in (104) demonstrate just as definitely that electric quantity has the dimensions of space, s, as required by the theory of the universe of motion.

140. From (139) it follows that there are two distinct kinds of electric and magnetic phenomena: (1) the *electric current* and *electromagnetism*, in which the basic entities are units of electric quantity (dimension s), acted upon by forces due to voltage differences, and (2) the phenomena classed as *electrostatic* and *electromagnetic*, the basic units of which are units of electric charge (dimension t/s) and magnetic charge (dimension t^2/s^2), acted upon by forces due to potential differences.

141. Electric charges moving through matter or through a gravitational field are carried by

particles or atomic constituents with rotational characteristics similar to those of the particles. The movement of these carriers produces electromagnetic effects, while the charges that are being carried produce electrostatic effects.

142. From (141), an aggregate of charged electrons has both a voltage and a potential.

(This explains the operation of such devices as the Van de Graaf generator, in which charged electrons at a low potential flow into a storage sphere in which the potential may be very high. A flow in this direction would be impossible if, as asserted by present-day theory, only one force, electric potential, is operative. But the foregoing development of theory shows, that there are actually two forces involved, and the direction of flow depends on the voltage differential, not on the potential difference. The voltage in the storage sphere is determined by the electron concentration, and may be low, even when the potential is in the million volt range.)

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4. Astronomical Implications

In the preceding Sections, we have presented a step-by-step deduction from the fundamental Postulates of the *Reciprocal System* of theory of the phenomena of the physical universe pertaining to the atomic domain. In this Section, we carry forward these deductions to the astronomical field and show how phenomena, some of which have not had proper explanations in conventional theory, emerge logically from these deductions. This Section, therefore, serves to demonstrate the *general* nature of the Reciprocal System of theory.

143. At this point, we will need to take into account the concentration of energy in the vicinity of matter subject to electrical ionization, and some consideration of the nature of this concentration will be required. As long as atoms or aggregates are free to move unidirectionally, there can be no significant spatial (volumetric) concentration of their kinetic energy. Such a concentration is accomplished by *containment*. Initially, the spatially restricted motion, *thermal motion*, as we will call it, is contained within the individual units of space. When the energy level is high enough to permit the atoms to escape from the spatial units, a force, exerted either by the walls of a container, or otherwise, is required for containment.

144. The level of containment outside unit space is measured by the pressure, the force per unit area, dimensions $t/s^2 \times 1/s^2 = t/s^4$. The product PV of the pressure and the volume is the energy of the contained thermal motion, dimensions $PV = t/s^4 \times s^3 = t/s$. We identify the thermal energy level as the temperature.

145. From (144), it follows that atoms of matter that are not confined, and therefore not subject to any pressure, cannot have temperatures above the very low levels at which they are able to escape from the individual spatial units. Free translational motion of an aggregate of matter likewise has no temperature effect. The motion of this aggregate as a whole is independent of the thermal motion of its constituents.

(Temperatures of millions of degrees are currently reported as applying to individual atoms and molecules in the vicinity of certain astronomical objects. From the foregoing, it follows that these temperature estimates are erroneous. Temperatures of unconfined matter are in the range of a few degrees, not in millions of degrees.)

146. Ionization is produced by a transfer of speed displacement to rotational vibration from some other form of motion, under appropriate circumstances. Thermal motion is one such source. The degree of ionization of the atoms of an aggregate increases with the temperature of the environment in which the aggregate is located, and at extremely high temperatures all elements are completely ionized.

147. From (95), the translational motion of masses, including the confined thermal motion, is outward. From (115), the electric ionization is also outward. Thus a further increase in temperature beyond the level of complete ionization ultimately brings the atoms up to a limiting level at which the sum of the outward ionization and the outward thermal motion is equal to unity. This unit outward motion then neutralizes one unit of the inward rotational motion. As indicated in (91), both units revert to the linear status, converting the rotational vibration and a unit of the rotation to kinetic energy. mass t^3/s^3 becomes energy t/s.

148. The conversion factor relating a unit of mass to a unit of energy has the dimensions s^2/t^2 (the dimensions of the second power of speed) and unit magnitude. The energy equivalent of a mass is therefore the product of the mass and the second power of unit speed (the speed of light).

149. As to the question of the result of further additions of thermal motion beyond the limiting point defined in (147) (the *destructive temperature limit* of the particular element under consideration), we must first return to (59), where we deduced that the maximum addition to the speed of a motion combination in any one dimension—that is, the amount that can be added to a zero base—is two units. In these terms of reference, the range is from zero to +2. In terms of displacement from the natural datum at unity, the range is from +1 to -1 (or from -1 to +1, as the identification of the conventional zero with +1 rather than -1 is purely arbitrary). The first added unit of speed eliminates the unit of speed displacement (+1), and the second adds a unit of time displacement (-1).

150. Since there are no fractional units of speed, the reduction of linear speeds to levels below unity in the manner described in (44) can be accomplished only by introduction of units of inverse speed. This is motion in time, but the atom is moving gravitationally in space in the other two scalar dimensions, and the net total scalar motion is therefore in space. It follows, in accordance with (47), that the increments of motion in time in the range between zero and unit speed act as motion in equivalent space.

151. Elimination of displacement in space (increase of speed) can continue only up to the unit speed level, at which point all displacement has been canceled. A speed greater than unity therefore cannot be attained by means of this process.

(This is the explanation of the observed inability to accelerate material objects to speeds in excess of the speed of light by application of electrical forces.)

152. As noted in (151), the limit at the unit level is on the capability of the process, not on the speed itself, and it does not preclude an increase in the speed above the unit level by

means of a different process. Where speed is available in full units, it may be added directly, up to the absolute limit, which, as stated in (59), is two one-dimensional units. Because an increment of speed above unity is a scalar motion in time (equivalent space), the extension of the linear motion in space into the second unit is distributed over all three time dimensions. As in the rotational situation of (91), the existence of three-dimensional units of speed then makes intermediate speeds between unity and two full linear units possible.

153. The aggregation of matter under the influence of gravitation noted in (34) applies to objects of all sizes. Because of the diversity of conditions there is no uniform aggregation pattern, but since gravitation is omnipresent, the average mass of all major classes of physical objects necessarily increases with advancing evolutionary development—with the evolutionary age, we may say.

154. The process of aggregation results in the conversion of gravitational motion into thermal motion (heat). Coincidentally, there is a loss of heat from the surface of each aggregate, due to radiation. But the mass, which determines the rate of heat production, other things being equal, increases more rapidly than the surface area. The temperature of a large aggregate is therefore a function of the mass, as long as the aggregation process continues.

155. Extremely high temperatures are reached only in very large aggregates of matter. If the aggregate is large enough to reach the destructive temperature limit of the heaviest element present, this activates the process of conversion of mass to thermal energy described in (147). We identify such an aggregate as a *star*.

156. Since the maximum degree of electric ionization of an element is equal to its atomic number (127), the heavier elements have a greater content of ionization energy, and therefore require less thermal energy to reach the destructive temperature limit, the temperature at which the total of these two energy components attains the unit level (149). If the stellar temperature continues rising, the elements reach their destructive limits in the inverse order of their atomic numbers.

157. The principle that small numbers are more probable than larger numbers applies to the formation of the elements (with some modifications due to other factors). The heaviest elements are therefore present in the stars only in relatively small concentrations, and the energy released in their destruction is dissipated by radiation from the stellar surfaces. As successively lighter elements reach their destructive limits, the concentration of the individual element arriving at the limit increases, and eventually this process reaches an element that is present in quantities that produce more energy than the radiation mechanism can handle. The excess energy then blows the star apart in a gigantic explosion. We identify the overabundant element as *iron*, and the explosion as a *Type I supernova*.

(Here the development of the theory leads directly to an explanation of a phenomenon for which no generally accepted explanation has been derived from astronomical theory.)

158. From (154), the temperature limit of a star is also a mass limit. From (153), the attainment of this mass limit is a result of advanced evolutionary age. The stars that

explode as Type I supernovae are therefore mature stars of approximately the same mass. Thus all Type I supernovae have the same general characteristics.

(The astronomers agree that all Type I supernovae are very much alike, but they have no explanation for the similarity.)

159. When the energy released in the supernovae explosion is added to the already high thermal energy level of the surviving portions of the interior structure of the star, a substantial portion of the explosion products are accelerated to speeds in excess of unity, in the manner explained in (152). From (46) and (47), the motion of these products takes place in the spatial equivalent of outward motion in time, which is inward in equivalent space. The aggregate of these very high speed products thus undergoes a drastic spatial contraction, and appears to observation as a small star with a density vastly greater than that of any aggregate of matter existing in the terrestrial environment. We identify this high density aggregate as a *white dwarf star*.

160. In ordinary stars (those with component speeds below unity) of a given class, the more massive stars are the larger; that is, they occupy a greater amount of three-dimensional space. From (46), the more massive white dwarf stars occupy the spatial equivalent of a greater amount of three-dimensional time, which is less equivalent space. According to the theory of the universe of motion, the more massive white dwarf stars are therefore smaller than the less massive ones.

(This deduction is confirmed by observation.)

161. In ordinary stars the spatial density gradient from the surface to the center of the star is positive; that is, the center is the region of greatest density. From (46), the temporal density gradient of a white dwarf star is also positive, which means that the center of the star is the region of greatest density in time, or least density in the corresponding equivalent space. Thus the spatial density gradient is greatest at the surface, and the lowest at the center.

162. Little or no translational motion in space is imparted to the white dwarf by the supernovae explosion. It therefore remains in the spatial region heavily populated with low speed explosion products, and accretes a substantial amount of these products by reason of its gravitational effect. The surface layers of the younger white dwarfs thus have a composition similar to that of their environment: predominantly hydrogen, with a minor amount of helium, and minute amounts of other elements. Because of the inverse density gradient (161), the hydrogen moves downward preferentially toward the center of the star, leaving the surface layers of the older white dwarfs enriched in helium.

(This, too, is confirmed by observation. A substantial proportion of the white dwarfs are reported to have helium-rich surface layers, extending up to "nearly pure helium atmospheres." Current astronomical theory has no explanation of this reversal of the normal density relations.)

163. In the supernovae explosion (157), the speeds imparted to the outer portions of the exploding star are less than unity. These explosion products therefore expand outward in space. Their motion is, however, subject to resistance from dispersed matter in the environment, and to the gravitational effect of the exploding aggregate as a whole,

including the white dwarf that does not participate in the outward movement. These opposing forces ultimately terminate the expansion and initiate a contraction. Thus most of the ejected matter is eventually recondensed into a star. The typical product of a Type I supernovae is therefore a double star system consisting of a diffuse A component on or above the main sequence and a dense B component (white dwarf or system of planets) below the main sequence.

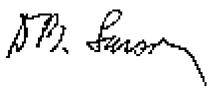
(This deduction from the premises of our theory *requires* the existence of double star systems as a direct consequence of the nature of the supernovae process, and explains why so many of these systems consist of dissimilar objects. The present state of astronomical knowledge in this area is described by the following quotation from a current astronomy textbook: “Our hopes of understanding all stars would brighten if we could explain just how binary and multiple stars form... Unfortunately we cannot.”)

164. Any explosive event comparable in intensity to a Type I supernovae ejects some products at speeds greater than unity. The explanation given in (159) for the extremely high density of the white dwarfs is equally applicable to these other high speed products.

(This accomplishes a significant simplification of astronomical theory, as the currently accepted explanation of the white dwarf density cannot be extended to such extremely dense objects as quasars, pulsars, x-ray emitters, and dense galactic cores, and separate explanations have had to be developed for the density of each of these types of objects.)

DEWEY B. LARSON: THE COLLECTED WORKS

Dewey B. Larson (1898-1990) was an American engineer and the originator of the Reciprocal System of Theory, a comprehensive theoretical framework capable of explaining all physical phenomena from subatomic particles to galactic clusters. In this general physical theory space and time are simply the two reciprocal aspects of the sole constituent of the universe–motion. For more background information on the origin of Larson's discoveries, see Interview with D. B. Larson taped at Salt Lake City in 1984. This site covers the entire scope of Larson's scientific writings, including his exploration of economics and metaphysics.



Physical Science

The Structure of the Physical Universe
The original groundbreaking publication wherein the Reciprocal System of Physical Theory was presented for the first time.

The Case Against the Nuclear Atom
"A rude and outspoken book."

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