

Free from; <http://www.reciprocalsystem.com/ce/index.htm>

(PDF made on 24 July 2009)

THE COLLECTED ESSAYS OF DEWEY B. LARSON

FUNDAMENTAL CONCEPTS

[Just What Do We Claim?](#)
[The Nature of Time](#)
[The "Arrow of Time"](#)
[The Physical Nature of Space](#)
On Space Translation
[The Case of the Colliding Photons](#)
[Reference Systems](#)
[Dimensions in the Universe of Motion](#)
[Step-by-Step](#)
[The Dimensions of Motion](#)

PHYSICS

[Theory of Solids](#)
More on Solid Cohesion Theory
[The Inter-Regional Ratio](#)
[The Effect of Gravitation on Radiation](#)
Superconductivity

ASTRONOMY

[Astronomical X-ray Sources](#)
[The Crab Nebula Pulsar](#)
[Quasars, Three Years Later](#)
[Quasars, How Big Are They?](#)
[Gravitation and the Galaxies](#)
[Supernova 1987A](#)

The Density Gradient in White Dwarf Stars

PHILOSOPHY OF SCIENCE

The Conceptual Foundations of Physical Science

Is Relativity Conceptually Valid?

The Current Status of Physical Theory

The Rydberg Constant and Zeno's Paradox

Changing Concepts of the Nature of Motion

Some Reflections and Comments

Some Anniversary Thoughts

A Note on Metaphysics

Some Thoughts on the Reciprocal System

A Rejoinder to K.V.K. Nehru

Draft Letter to Friends of Science

Comments on Some Issues Raised at the 1978 Conference

Comments on Letter from Edwin Navarro

The Current Status of Physical Theory

JUST WHAT DO WE CLAIM?

The task of presenting the case for a new system of thought is a difficult one at best, and in order that it may be successfully accomplished it is essential to confine the discussion to the specific points at issue, and to avoid being drawn into controversies regarding matters which, at least for the present, are irrelevant. This is particularly important because the principal interests of most of those to whom the presentation is addressed, the items that they will want to talk about, lie along the periphery of scientific knowledge, the scene of most current research activity, whereas the development of a new system of theory must necessarily begin with fundamentals, and in the early stages will not reach the outlying “fine structure” except in certain special cases. This point should be brought out early in the discussion in order to eliminate the necessity of giving a series of negative answers to questions on the order of “Does the theory explain thus-and-so?”

It should be emphasized that we do not claim that the reciprocal system in its present stage of development is ready to supply the explanations of all of these fine details, and the unavailability of any particular explanation thus has no relevance to the point now at issue. The question that is now up for consideration is whether the claims that we do make can be substantiated, and the only items that have any significance for present purposes are those that have some bearing on this issue. It is essential, therefore, that the claims which we are making on behalf of the reciprocal system be clearly and specifically defined. They can be expressed as follows:

- I. The reciprocal system is a general physical theory, one that derives all of its conclusions in all physical fields from a single set of basic premises—the only such general physical theory that has ever been formulated.
- II. Within the range of phenomena thus far covered in the development of the consequences of the fundamental postulates of the system, an area which includes the basic features of all of the major branches of physical science and a wide variety of subsidiary phenomena, all of the conclusions that are reached from the theory are consistent with the physical facts that have been definitely established by observation and measurement (although they do not necessarily agree with inferences from or extrapolations of those facts, nor with theories previously devised to explain the facts).
- III. Because all conclusions are derived from the same basic premises, the entire structure of theory is a single integral unit that is not subject to modification or adjustment. Every comparison of theory with observation is therefore a test of the validity of the theoretical system as a whole. Thus each of the thousands of such tests that have already been made without finding a discrepancy has reduced the probability that a discrepancy will ever be found, and as matters now stand it is practically certain that the theoretical universe of the reciprocal system is a true and accurate representation of the actual physical universe.

All theories must begin with assumptions. Heretofore we have had no general physical theory. As one prominent physicist expresses it, we have had only a “a multitude of different parts and pieces that do not fit together very well.” Each separate theory—each of the “parts and pieces”—has found it necessary to begin with assumptions about the particular field to which it applies. Thus theories of liquids are based on assumptions about liquids, theories of cosmic rays on assumptions about cosmic rays, theories of the structure of matter on assumptions about matter, and so on. A very significant feature of the reciprocal system is that it makes no assumptions at all about these individual physical fields. It makes no assumptions about liquids, nor about cosmic rays, nor about matter. As stated in I, all of its conclusions about these phenomena are based entirely on the assumptions, or postulates, regarding the nature of space and time that constitute the foundation of the theoretical system. This is a very important point. The mere fact that the development of the consequences of a set of postulates with respect to space and time is able to arrive at specific conclusions about phenomena in all major fields of physical science is in itself a strong indication that the theoretical system thus derived is a true representation of the physical facts.

Claim II is simply a statement that the conclusions derived from the new, theory are consistent with all established knowledge. These conclusions do conflict with many ideas now, prevalent including some generally accepted theories, but this again is irrelevant. Our claim is that the new theory is correct, not that it is better than the theory of limited scope which is now accepted in the particular field under consideration. “Better” is a subjective concept that rests mainly on non-scientific criteria, and is wide open to differences of opinion. In order to present a clear-cut and conclusive case for the new theory it is advisable to stick to the objective facts specified in I and II and to avoid subjective issues.

Likewise there is nothing to be gained at the present time by any argument in support of the validity of Claim III. When we verify Claim II we automatically put the new system into a position where a careful and painstaking examination of the system and its potentialities by the scientific community is unavoidable. Inasmuch as we are aiming at nothing more than this modest objective for the present, the validity of Claim III is not now an issue, although it obviously will have considerable importance in the long run.

THE NATURE OF TIME

“To attempt a definite statement as to the meaning of so fundamental and underlying a notion as that of time is a task from which even philosophy may shrink,”¹ says Richard Tolman in his classic treatise on Relativity. But the “notion” of time is basic in every field of science. In legal documents we often see the expression “Time is the essence of this contract.” It is no less the essence of physical theory—without the symbol t and all that it stands for, there would be little left in physical science. In order to make a definite and meaningful statement about *any* physical phenomenon it is therefore necessary to define the concept to which the name “time” is to be attached. This definition may not actually be expressed—indeed it is seldom expressed except in such basic works as Tolman’s—but in any work that lays claim to scientific accuracy, the exact meaning of this concept *must* be specified, implicitly if not explicitly. Those who use the concept without defining it are not evading this requirement; they are simply accepting a definition set up by someone who has preceded them. How then does science meet this serious challenge at the very base of its theoretical structure: the absolute necessity of a precise and unequivocal definition of an entity that is so difficult to grasp that the mere thought of trying to understand it appalls the scientist? Tolman tells us frankly how he and his colleagues have met this issue:

“we shall assume without examination the unidirectional, one-valued, one-dimensional character of the time continuum.”²

Physical science justifiably prides itself on the “rigor” of its treatment of the subject matter which it covers: precise definitions, clear-cut distinctions, careful and critical development of theory by exact logical and mathematical processes. But when we examine the foundations of this work, we find that the entire structure of carefully developed theory rests upon nothing more substantial than three items which are “*assumed without examination.*” Scientific precision has here taken the form of precise formulation of pure assumptions: the most unreliable of all instruments of thought. Unfortunately, precision is no substitute for validity; an assumption is no less uncertain and speculative because it is expressed in definite and exact language. As matters now stand we have not grasped the essence; we see it only through a thick veil of uncertainty. And without the solid foundation which only a clear understanding of the true properties of time can give us, all of our vaunted logical and mathematical precision is spurious; indeed, if the premises are false, the more precise the logical development the more certain we are to arrive at the wrong conclusions. The physicist who fills pages of the *Physical Review* with complex mathematical calculations may be giving us a development that, in itself, is faultless, but if any of the properties of time that have been “assumed without examination” are not valid, then he is introducing some kind of an error every time he uses the symbol t and, in spite of its impeccable outward appearance, the work as a whole may be completely wrong.

If physical science had been uniformly successful in building up a consistent, integrated structure of theory, fully capable of meeting all demands upon it, this serious defect in the underpinnings of the structure could well be viewed with equanimity, on the ground that the assumptions are justified by the results thereof. It is admitted on all sides, however,

that in spite of the spectacular successes that have been achieved in many areas, physical science is still far from having a comprehensive and satisfactory basic theory. In fact, many scientists have given up in despair, and no longer consider the construction of such a theory to be within the range of possibility. C.N. Yang, for instance, was quoted in a recent news item as “*expressing some doubts about the ability of the human brain in general and his in particular to accomplish this task,*”³ and Henry Margenau admits that “*To the outsider the conclusions reached by a modern physicist seem almost like a declaration of the bankruptcy of science.*”⁴

In the light of this situation it would seem that science has now reached the point where it can no longer avoid facing the issue as to just what the properties of time actually are. Of course, we have no positive knowledge that errors in the assumptions regarding these properties are responsible for, or have contributed to, the failure to construct a satisfactory basic physical theory, but where the best efforts of the most competent investigators over a long period of years have failed to produce the expected results, it is certainly much more likely that the fault lies in basic premises that have been assumed arbitrarily and “without examination” than in any lack of “ability of the human brain” to apply logical and mathematical processes to these premises. A thorough and painstaking examination of the validity of the assumptions that have been made concerning the properties of time is therefore very much in order.

The question then arises as to how this issue can be approached. The scientific profession has hitherto believed that there is no alternative to the use of pure assumptions of the kind listed by Tolman, but the investigations which I have carried out have disclosed that it is possible to apply a much more reliable process to this problem, and thereby to arrive at some different conclusions as to the properties of space and time which eliminate most, if not all, of the basic difficulties that physical science now faces. This new approach substitutes a process of *extrapolation* for the arbitrary assumptions heretofore utilized. It is true that extrapolation is also, in a sense, a process of assumption, but the extrapolation assumption, the assumption that the situation or relation existing in the known region also exists in the unknown region, is inherently vastly superior to *any* other assumption that can be made, with a far greater probability of being a true representation of the physical facts, and in any case where extrapolation is possible, it is obviously sound policy to give the consequences of such an extrapolation a complete and thorough examination before anything else is even considered.

As a general proposition, the superiority of this approach is not open to serious question, but a *direct* extrapolation does not appear feasible in this case, as we have no positive knowledge as to what the properties of space and time actually are *anywhere*, and consequently there is no adequate base from which to extrapolate. All previous investigators have therefore relied upon assumptions—some related to our rather vague general impressions of space and time, others wholly conjectural—not because they preferred to do so, but because they felt that they had no option. The method which I have employed to overcome the existing difficulties is to approach the question indirectly, beginning with an examination of the relation between space and time. This relationship is one that has never been adequately explored heretofore. In the days of Newton, its existence was not recognized at all, the two entities being regarded as

completely independent. Since then there has been a growing realization that they are not independent and that basically we must deal with space-time, not with space and time individually. Thus far, however, it does not appear to have been suspected that the existing concepts of the fundamental *nature* of space and time may be in error—that time, for instance, may be actually something other than a “unidirectional, one-valued, one-dimensional continuum” —and the hypotheses that have been advanced as to the character of the space-time relation, such as Minkowski’s concept of a four-dimensional continuum, have retained these basic assumptions and thus have simply plied speculation upon conjecture.

Instead of starting with arbitrary assumptions, the first move in the present investigation has been to extrapolate to the universe as a whole the relation between space and time which we find existing in the known region of the universe. In this known region the relation between space and time is motion, and in motion space and time are reciprocally related. This is not surmise or assumption, nor is its accuracy in any way open to doubt. It is positive knowledge from which we can extrapolate. Irrespective of the nature and properties of space and time individually, the method of extrapolation leads directly to the conclusion that we should postulate a *general reciprocal relation between space and time effective throughout the universe*.

Of course, *any* new viewpoint that conflicts with long-standing beliefs concerning space and time, no matter how firmly based it may be, will seem strange and hardly credible on first consideration, but nothing that we actually know about space or time is inconsistent with this reciprocal postulate. The truth is that we know very little about either of these entities. Time has always been mysterious and elusive, but even space, which seems so much more understandable, has been a difficult problem for those who have sought to discover its true nature, and no general agreement on this score has ever been reached. To Aristotle, space was merely a *relationship* between physical objects; to Democritus and his fellow atomists it was a *container* in which such objects exist; to Einstein it was a *medium* connecting these objects. Certainly it cannot be claimed that there now exists any positive knowledge about the inherent nature of space to which a new theory must conform. On the contrary, the conclusion of this current investigation, which, in effect asserts that space is merely an *aspect of motion*, has a much greater *a priori* probability of being correct than any of its predecessors, since it has been reached by way of a more reliable process. Nevertheless, the proof of the pudding must be in the eating; that is, we must develop the consequences of the new concept and see whether they give us a more logical and consistent picture of physical relations than the currently accepted ideas.

It will not be possible in a short article of this kind to describe all of the results that have been obtained in the application of the reciprocal hypothesis to a wide variety of physical phenomena during the many years that this investigation has been under way, but the general nature of the results can be demonstrated by a typical example, and in the discussion that follows, the consequences of the reciprocal postulate will be developed far enough to produce an explanation of gravitation; something that no other physical theory has been able to do. The gravitational findings are particularly interesting because they not only demonstrate the ease with which this new development surmounts the difficulties that have stood in the way of progress in such areas as this, but also show why

we get a distorted view of space and time from our everyday experience, and why most of the inferences as to the nature of these entities that we draw from such experience are erroneous and misleading.

No doubt many readers will be surprised at the assertion that gravitation still remains unexplained, as there is a very common misconception that Einstein's General Theory of Relativity supplies such an explanation. But, as Willem de Sitter has pointed out very clearly *no* hypothesis thus far advanced to *explain* gravitation "has ever had the least chance, they have all been failures." Einstein's contribution, de Sitter says, is to make gravitation identical with inertia, and thus to put it in the category of "one of the fundamental facts of nature, which have to be accepted without explanation, like the axioms of geometry."⁵ After fifty years, the inadequacy of this treatment is clearly apparent. As R. H. Dicke puts it, gravitation is still an "enigma," and "It may well be the most fundamental and least understood of the interactions."⁶ A recently published review of the proceedings of the First Soviet Gravitational Conference confirms this opinion with the following comments: "... the gathering seemed painfully perplexed with endless questions, nearly all of which remain unanswered."⁷

The crux of the gravitational problem is the dilemma which no previous theory has been able to avoid: the apparent necessity of postulating either action at a distance, which is philosophically unacceptable to most scientists, or propagation through a medium, which is completely lacking in observational support and is faced with seemingly insurmountable practical obstacles. After three hundred years in which it has been agreed that these are the only two possibilities, the new development based on the reciprocal postulate now produces a third alternative that has been completely overlooked by previous investigators: one in which gravitation acts in a perfectly natural and understandable way, instantaneously, without an intervening medium or a medium-like space, and in such a way that it cannot be screened off or modified in any way; all of which are exactly in accord with what our observations have indicated.

To begin the explanation of how these results were obtained, let us now return to the basic assumption of a reciprocal relation between space and time. It is evident that this assumption necessitates a further postulate that space and time have the same dimensions, since quantities of different dimensions cannot stand in a reciprocal relation to each other. We can recognize three dimensions of space, and with the simplest assumption that is consistent with both the reciprocal postulate and the observed properties of space is that both space and time are three-dimensional. Limitation of both space and time to discrete units is also necessary in order to make the reciprocal postulate mathematically workable. Extrapolation of the relation between space and time that is observed in the phenomenon of motion thus leads directly to three conclusions about the properties of time and space which can replace the assumptions that the physicists have made "without examination" . Together with the further assumption that space-time as thus defined is the *sole* constituent of the physical universe, these can be combined into one comprehensive postulate as follows:

FIRST FUNDAMENTAL POSTULATE

The physical universe is composed entirely of one component, space-time (motion), existing in three dimensions, in discrete units, and in two reciprocal forms: space and time.

In addition to this First Postulate, which defines the physical nature of the universe, some further assumptions as to mathematical behavior will be necessary, and since this present development does not get into any difficulties of the kind that have forced modern physics to resort to the use of complex and abstruse mathematics, it will be possible to formulate the following simple postulate:

SECOND FUNDAMENTAL POSTULATE

The physical universe conforms to the relations of ordinary commutative mathematics, its magnitudes are absolute, and its geometry is Euclidean.

On examination of these two postulates, it is apparent that they require a progression of space-time similar to the progression of time as ordinarily visualized. Let us consider some location A in space-time. When one more unit of time has elapsed, this location has progressed to A+1 in time. Since one unit of time is equivalent to one unit of space, according to the First Postulate, this location has also progressed to A+1 in space. At the very outset, therefore, the new development confronts us with an important basic phenomenon which has not hitherto been recognized: a progression of space similar to the observed progression of time. We thus have an immediate opportunity to test the validity of the new system by observation of the actual physical universe. If space-time actually progresses, as the new theory contends, then we should be able to recognize some phenomena in which identifiable objects without inherent motion of their own are being carried along in space by the progression of space-time.

In order to simplify the question of a reference system, let us assume that a large number of such objects originate at the same space-time location, which means that they originate at the same space location simultaneously. Due to the progression of space-time these objects immediately begin moving outward, but outward in space-time is a scalar direction, and the spatial motions of the individual objects will be distributed over all possible directions in accordance with the probability principles. Hence if there actually is a progression of space-time, we should observe objects of this kind originating at various spatial locations and moving away from the points of origin in all directions and at a constant velocity. We do not have to look very far to find physical entities which display exactly this behavior. Throughout the physical universe there are sources of light or other electromagnetic radiation from which photons emanate in all directions and recede from the points of emission at a constant velocity. This radiation phenomenon therefore furnishes the definite independent evidence that is necessary to demonstrate the reality of the space-time progression.

Additional confirmation is provided by the motions of the external galaxies. All galaxies except our immediate neighbors are receding from us in exactly the same manner as the photons of light that originate in our galaxy, except for the fact that the relative galactic velocity is a function of the distance, and has only reached about one-fourth of the velocity of light at the extreme range of our optical telescopes, and perhaps one-half of the velocity of light at the greatest distance accessible to radio observation. The lower

velocities of the galaxies as compared to the velocity of the light photons are quite obviously due to the modifying effect of gravitation which, even at these enormous distances, still exerts a small force of attraction that operates against the progression. Thus the reality of the space progression, a basic feature of the new theory that has no counterpart in any other physical theory, is substantiated by two independent lines of evidence.

Space limitations preclude a detailed discussion of the development of the consequences of the Fundamental Postulates to the point where they require the existence of matter, but for present purposes it should be sufficient to say that this development indicates that the atoms of matter are rotating units in which the direction of rotation is opposite to that of the space-time progression; that is, irrespective of the *spatial* direction in which the atoms are moving, their *scalar space-time direction* is always *inward*, directly opposite to the *outward* motion of the space-time progression. Whereas the progression is continually carrying all physical objects outward away from each other, the inherent rotational motion of the atoms is carrying them inward toward each other. This is the phenomenon that we call gravitation.

As an aid in visualizing how gravitation operates, according to this theory, let us assume that a violent explosion has taken place and that we are looking at the results shortly thereafter without any knowledge of what has happened. We still see a cloud of flying particles apparently exerting a force of repulsion upon each other, and we will observe that this force has some peculiar characteristics: it acts instantaneously, without an intervening medium, and in such a way that it cannot be screened off or modified. According to the new development, gravitation is a force of the same general nature, except that it acts in the inverse direction: inward instead of outward. Like the apparent force which the particles of debris exert on each other, gravitation merely *appears* to be an action of one mass upon another; in reality each mass is *pursuing its own course independently of all others*.

Inasmuch as the motion of the progression originates everywhere and is constant regardless of location, whereas the gravitational motion originates at the location which the atom happens to occupy, and the component directed toward any other atom therefore decreases with distance in accordance with the inverse square relation, there is a point at which the two velocities are equal. Inside this equilibrium distance the gravitational motion is the greater, and there is a net gravitational effect. Beyond the equilibrium point the motion of the progression is the greater, and objects move away from each other, the net outward velocity increasing with the distance as the gravitational effect decreases. The actual behavior of the universe is exactly in accord with these predictions of the new theory.

Throughout the physical realm the new viewpoint as to the nature of space and time derived by the relatively straightforward and dependable process of extrapolation similarly resolves the dilemmas and difficulties which have resulted from basing physical theory on pure assumptions. It is evident from these results that space and time are actually entities of the same nature and that the great differences which we seem to see in them are merely the result of the gravitational motion of matter. Gravitation conceals the effect of the space progression in our immediate vicinity, and the progression is

observable only at extreme distances, hence the most evident property of space is its three-dimensionality. The progression of time, on the other hand, is unchecked by gravitation, and the velocity of the progression is so high that any motion in three-dimensional time is negligible (relatively) except at extreme velocities. We therefore recognize only the progression. But science is now penetrating the regions of extreme distance and very high velocities, where the progression of space and the three-dimensionality of time play significant roles, and in order to remove serious obstacles to a clear understanding of phenomena in these regions it will be necessary to take heed of the salient point disclosed by the extrapolation process of the present investigation: the fact that *both* space and time actually have *all* of the properties that have hitherto been attributed to *either* of them individually.

References

1. Tolman, Richard, *The Theory of the Relativity of Motion*, University of California Press, Berkeley, 1917, page 6.
2. Tolman, Richard, *ibid.*, page 27.
3. *Newsweek*, January 22, 1962, page 49.
4. Margenau, Henry, *Open Vistas*, Yale University Press, New Haven, 1961, page 63.
5. de Sitter, Willem, *Kosmos*, Harvard University Press, Cambridge, 1932, page 106.
6. Dicke, Robert H., *American Scientist*, March, 1959.
7. *Nature*, January 18, 1964.

THE “ARROW OF TIME”

From the mathematical standpoint, the quantity that enters into such relation as the equation of motion can be either positive or negative, and the fact that time is observed to move only in one direction is frequently characterized as an anomaly, a “puzzle.” But there is nothing puzzling about the direction of time if it is viewed in physical terms. Time, as a physical quantity—the time interval between two events, for instance—cannot be less than zero. The net magnitude of a quantity of time is therefore positive in all cases. The physical arrow points forward.

A related issue that remains unresolved in the present-day mathematical version of physical theory is the question as to why time has the characteristics of a continual flow. Paul Davies describes the situation in this manner:

It is one of the most perplexing puzzles in physics that the elementary conscious experience of time—the flow or motion of the present moment—is absent from the physicist’s description of the objective world.

The truth is that the physicists are not entitled to expect that their theories, which *compensate* for the errors in their basic premises by more complex mathematics, rather than correcting the errors, will answer the *physical* questions. For the answers we need to go beyond the mathematical relations and examine the physical aspects of the phenomena under consideration. This is what has been done in the development of the theory of the universe of motion. When time is examined in the light of the new information derived from this theory, we find that its “flow” is due to a motion of our reference system relative to the natural reference system, the system to which the universe actually conforms.

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 CASE OF THE COLLIDING PHOTONS

One of the issues that usually comes up at some point during any extended discussion of the fundamentals of the Reciprocal System of theory is what the writers of detective stories would probably call The Case of the Colliding Photons. This perennial stumbling block that troubles so many of those who try to follow the development of the theoretical structure was given some attention during the conference in Minneapolis, but inasmuch as there were still a number of question marks in the air when it became necessary to turn to other matter; a full review of the situation is no doubt in order.

As brought out in the publications which describe the theory of a universe of motion, the natural system of reference to which such a universe conforms moves outward at unit speed (the speed of light) with respect to a stationary coordinate system of reference. Any object which has no capability of independent motion, and is not acted upon by any external forces, remains stationary with respect to the natural system of reference, and it therefore moves outward from all other such objects at unit speed. It is not possible for two such objects to meet.

Atoms of matter are likewise carried outward away from each other by the outward progression of the natural reference system, in the same manner as the photons, but these atoms do have independent motions of their own. These atomic notions are inward, in opposition to the Progression, and if the atoms are within the applicable gravitational limits, the magnitude of the inward notion is greater than that of the outward progression. The total number of atoms subject to a system of interrelated gravitational motions constitutes what we call a gravitationally bound system. Atoms within such a system can collide under appropriate conditions.

Photons emitted by atoms in a gravitationally bound system have no capability of independent motion, but they are subject to external forces (that is, to motions of external origin) inasmuch as they participate in whatever motions the emitting aggregates of atoms may have had when the emission occurred. At the instant of emission, the photon is moving with the aggregate, and it has no mechanism whereby it can eliminate that motion. The progression therefore takes place outward in a reference frame defined by the emitting aggregate. Each such aggregate is the center of a sphere of radiation, and in a gravitationally bound system the spheres are coexistent. Photons of this radiation may therefore collide with other photons emitted within the bound system, or with atoms of that system.

Some objections have been raised to this explanation of the colliding photon situation on the ground that the addition of the unit speed of the photon to the preexistent speed of the emitting aggregate on that foregoing basis conflicts with the established fact that the speed of light is independent of the speed of The emitting object. However, this objection is based on an erroneous assumption. It assumes that the changes in the relative spatial positions of the photons are determined by the relative speeds, which is not true

I have discussed the general question of motion at high speeds at some length in most of my books (see, for instance page 30 of *Quasars and Pulsars*). In the illustration that I

have generally used, I consider two photons emitted simultaneously from a common stationary source in opposite directions. At the end of one unit of clock time photon a has reached point A, one spatial unit distant from the point of emission, which we will designate as O. This distance OA in the stationary reference system is an absolute magnitude that is totally independent of anything that any other photon may do. During the same interval of clock time photon b moves to point B one unit of space distant from O in the direction opposite to A. The distance OB in the stationary reference system is also an absolute magnitude totally independent of anything that may happen to any other photon. Thus, during one unit of clock time the spatial separation between photons a and b in a stationary three-dimensional frame of reference, which was originally zero has increased to two units. This is a simple objective fact that does not depend in any way on the particular theoretical system in whose context the situation is viewed.

If we replace photon b by a material object that moves with a speed of natural unit, the separation at the end of one unit of clock time is $1\frac{1}{2}$ spatial units. If we substitute a stationary object for photon b, the resulting separation is only 1 spatial unit. In all of these cases, the separation and consequently the time rate of change of the relative spatial positions of the moving objects is determined by a combination of the individual speeds involved. But both conventional theory and the Reciprocal System agree that the speed of a relative to b is unity, the speed of light, in all three examples. This the measured speed of the photon does not determine the relative spatial position that it will occupy at any particular time.

This may seem paradoxical, but the explanation is that any excess of the rate of spatial separation over one unit of space per unit of time is offset by motion in three-dimensional time, and therefore has no effect on the relative speed. The same considerations apply where photons are emitted from a moving object. Although the measured speed of the photon is simply the magnitude of the progression of the natural reference system, and is independent of the motion of the emitting object, the presumed conflict between the constant speed of light and the photon collisions is therefore without foundation.

REFERENCE SYSTEMS

As reported in the October 1977 issue of *Reciprocity*, I am now in the process of preparing the first volume of a revised edition of the book in which I introduced the Reciprocal System of theory, *The Structure of the Physical Universe*, a book which has been out of print for several years. As the successive chapters of the manuscript are completed, I have been circulating them for review and comment by a number of those members of the New Science Advocates with whom I have corresponded on the subject matter. One point that is already evident from the first comments that have been received is that it will be necessary to go into more detail in the discussion of the way in which our apprehension of the basic physical motions is affected our choice of a reference system. I had already recognized this to the extent to including a chapter entitled "Reference Systems" in the draft of the revision that is now being circulated, but it seems clear from the comments that some aspects of the situation will require further clarification. I therefore intend to make some additions to the manuscript, but in the meantime a review of the principal points at issue may be of interest to the readers of *Reciprocity*.

The first point to be noted is that whether or not an object is in motion, and the amount of that motion, if any, depends on the reference system. An object which is stationary in one reference system is moving in any reference system that is in motion relative to the first system. Whether we see the motion of the object as a complex motion, a simple motion, or no motion at all depends on the reference system to which we relate it. One of the important findings of modern physics, confirmed by the Reciprocal System, is that there is no *absolute* reference system. No stationary reference system that we may select has any valid claim to superiority over another.

Another significant finding is that a reference system for motion necessarily includes a time datum as well as a space datum. For most ordinary purposes we refer changes in spatial position to the surface of the earth, but we realize that these motions would have some very different aspects if we adopted a different reference system, one based on the sun, for example. The development of the Reciprocal System of theory now shows that for a complete definition of a motion we must also specify position in time relative to some selected reference system, This is the fundamental fact that has heretofore gone unrecognized because it has been assumed ("without examination," as one prominent physicist puts it) that time always progresses uniformly at the rate indicated by a clock. On the basis of this assumption, the time registered by a standard clock is the same at all points in space. This makes it possible to represent motion in a coordinate system which provides only for variability in the three dimensions of space; that is, a *spatial* coordinate system. When we are dealing only with relatively low velocities this is satisfactory, as the deviations from clock time at these velocities are negligible. At high velocities, on the other hand, the true rate of change of position in time is different from the rate indicated on a standard clock. In this case the conventional assumption that the standard clock registration is a correct measure of the change in time position is wrong, and it introduces an error.

The point that we now need to realize is that when we select some physical object, such as the earth, to define a spatial reference system, we are, by the same act, utilizing the

position of the earth in time to define a temporal reference system. If an object A is ejected from the earth with a speed x this means that the change in the position of that object in space relative to the earth's location in space divided by the elapsed clock time plus or minus the change of position of that object in time relative to the earth's location in time is x . If a similar object B is ejected from Mars at speed x , the same statements apply to the motion of that object relative to the reference system defined by Mars. But if it is now desired to express the velocity of B in terms of the reference system defined by the earth, everyone realizes that the change in the relative spatial position of Mars and the earth must be taken into account. What was not realized before the development of the Reciprocal System is that there is also a change in the relative position of these two planets in time, and whenever the magnitude of this change is significant it too, must be taken into consideration. The true measure of the speed is the amount of change of position in space divided by the total time including the amount of change of relative position in time. Clock time is a correct measure of the total time only at low relative speeds.

Much of the difficulty that some students of the theory are having in understanding the motion of photons of radiation could be avoided if it is recognized that although the photon motion is inherently scalar once a direction has been imputed to it in the context of the spatial reference system, the photon moves in the same manner as any other object. The object A in the preceding paragraph could just as well be a photon as anything else. A photon emitted from the earth moves away *from the earth* just as any ejected material object will do, not from any kind of an absolute position that the earth was occupying at the time of emission. There is no absolute reference system by means of which such a position could be defined. When one unit of clock time has elapsed, the photon will be one unit of space distant from the earth, and since, in this case, clock time is the total time, the speed is $1/1 = 1$.

As in the preceding illustration which referred to the motion of material objects, if we want to express the motion of a photon emitted from Mars in terms of a reference system defined by the earth, the spatial distance traveled by the Mars photon in the reference system during one unit of clock time will be $1+a$, where a is the effect of the relative motion of Mars and the earth. However the distance component a is traversed during a time a , which is separate and distinct from the one unit of time registered on the clock. The total time involved in the motion is there $1+a$ and the speed is $1+a/(1+a) = 1$. Thus the speed of the photon motion is independent of the reference system, but the *spatial location* is not.

No doubt some of the misunderstanding that I am now trying to correct is due to my use of the term "natural reference system." Even though I have continually emphasized that space and time do not constitute a setting or background for physical action, and that there is no absolute reference system, it has been widely assumed that this "natural reference system" is such a setting. As one correspondent puts it, "Whenever you talked about the progression of space...we instinctively assumed you were talking about the expansion of some background space...Objects not participating in such an expansion would emit photons by simply 'cutting them adrift in the expansion.'" The term "natural reference system," as I am using it, has no such implications. A spatial reference system

can be stationary, in which case the distances between its various parts remain the same as time progresses. Or it can be a moving system, in which case the distances between its various parts increase as time progresses. Inasmuch as each of the primitive undifferentiated nations that are the fundamental units of the physical universe involves one unit of space in association with one unit of time the datum for physical activity — the *natural* reference system — is a system in which the various parts are moving outward (that is, distances are increasing) at a uniform unit speed. This is the natural system because it is the system in which any object., such as a photon, that has no capability of independent motion is stationary. It is essential to use the concept of such a reference system in the development of theory, and a name must be assigned to it. The word “natural” is intended to express the fact that this system moving at unit speed is the system to which the universe actually conforms; that is, the only system with respect to which an object that *cannot* move is not represented as moving. While I realize that the term “natural reference system” is frequently misinterpreted, I do not believe that there is any alternate wording less open to misinterpretation that will express the true meaning.

The concept of an expanding system of reference is applicable only to scalar motion. It is unfamiliar because the existence of inherently scalar motion was not recognized prior to the development of the Reciprocal System, notwithstanding the fact that motions such as those of spots on an expanding balloon are obviously different *in kind* from ordinary vectorial motions. A reference system for scalar motion in a three-dimensional universe necessarily takes the form of a sphere. As the imputed direction of a scalar motion in such a universe is determined by chance, an object which has moved a scalar distance d from its point of origin during a certain interval will be found somewhere on the surface of a sphere of radius d .

For the purpose of explaining the relation of such a reference system to the more familiar types, let us assume an object A to be motionless. A sphere centered at A then constitutes a stationary system of reference (magnitudes in which can, of course, be expressed either in polar or rectangular coordinates). A sphere centered at object B which is not moving relative to A is part of the same reference system. A sphere centered at object C, which is in motion relative to A is *another* reference system of the same kind. However, if the sphere centered at A is assured to be expanding at rate x , this constitutes a reference system of a different kind: a moving system. In the special case where the rate of expansion x is unity, one unit of space per unit of time, we have the *natural* moving system, the reference system to which the basic units of the universe actually conform. If an expanding sphere of this kind is centered at object B instead of object A, it is another part of the natural system. However, both A and B can occupy positions in the same stationary reference system only if they are moving inward gravitationally. For all practical purposes, therefore, it can be considered that a separate system of reference is centered at B. It is true that all points in reference system B are moving outward from A but this_ outward motion is counterbalanced by the inward gravitational motion of equal magnitude, so that the only *effective* ration of photons emitted from B is the nation outward from B.

Generalizing the principle brought out in the foregoing paragraphs, we may say that scalar motion can be represented in a stationary three-dimensional system of reference

only if *reference points* are defined. This limitation on our ability to represent motion in a fixed coordinate system may be annoying, but if we want to understand the physical universe we will have to take it as it is; we cannot force it to conform to what we think it ought to be, or to what we find convenient. The discovery that the physical universe transcends the limitations of our usual reference systems is one of the most significant of the results that have been obtained from the development of the Reciprocal System of theory. It is now clear that this universal cannot be forced into the mold that previous physical theories have prepared for it. There is no valid reason why physical action *must* be limited to those events and those phenomena that can be represented in the reference systems that the human race is capable of constructing, and the finding of the Reciprocal System is that it is *not* so limited. The inability to deal with scalar motion on the same basis as vectorial motion is only one of a number of instances where the universe refuses to stay within the boundaries of what is convenient for the human investigator.

Inability to represent change of position in time in a spatial reference system is another case of the same kind. I am continually receiving letters from individuals who say that they need help because they are having difficulty in “drawing a diagram” to represent some motion in which change of position in time is involved, according to the theoretical findings. I cannot give any help in these cases, because motion in *time cannot* be represented in a *spatial* diagram. We are able to represent low-speed motion in such a diagram because no significant change of relative position in time is involved, but as soon as the speed is great enough to introduce such a change, the spatial diagram can no longer represent the motion accurately.

This is not something that is peculiar to the Reciprocal System. The *reason* for the difficulty at high speeds was unknown prior to the development of this new theoretical system, but its *existence* has long been recognized. It is a matter of fact that has to be faced regardless of what physical theory is accepted. In order to understand just what is involved, it should be realized that a diagram, or graphical representation, of a motion does not give us a true picture of that motion unless the spatial positions of the moving objects as shown in the reference system are consistent with the speeds. For instance, if the distance between A and B increases by x in time t , then the speed must be x/t ; otherwise the motion is not correctly represented. But no spatial reference system can maintain this kind of consistency in representing high-speed motion.

The two-photon case that I have frequently discussed in my publications demonstrates this point. In this illustration, we assume two photons, A and B, emitted simultaneously from an object O in opposite directions. At the end of one unit of clock time, A and B are separated by two units of distance, and $x/t = 2/1 = 2$. But experiments show that the speed of A relative to B is only 1. Clearly, either the distance entering into the determination of the speed differs from that measured in the reference system, or the time differs from the uniform rate of progression that has to be assumed in order to make it possible to represent motion in a spatial coordinate system. In either case, the spatial reference system is not capable of representing the motion accurately. Current physical theory, based on Einstein assumptions, simply says that the coordinate positions have no meaning at high speeds. As expressed by Moller, “In accelerated systems of reference the

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

Those who insist that we should be able to represent every motion by a spatial diagram are demanding something that has long been known to be impossible. Perhaps some day a device may be invented whereby change of position in three dimensions of space and change of position in three dimensions of time can be accurately represented in a diagram that can be comprehended by the human mind. In the meantime, we will simply have to recognize that some natural phenomena are not amenable to our cherished diagrammatic modes of representation, regardless of what kind of a theory we may use in our attempt to understand them. The only difference between the Reciprocal System and other theories, so far as this point is concerned, is that this new theoretical system has clearly identified the phenomena that the conventional systems of reference are unable to handle, including some phenomena such as scalar motion that have heretofore been overlooked, largely *because* of the tendency to insist that nature must conform to what the human theorists find convenient.

There is no good reason, however, why we should be disconcerted because nature refuses to make things easy for us. If we start with the basic units of motion and build the possible combinations of these units step by step in accordance with the rules specified in the fundamental postulates of the Reciprocal System, we define the physical universe, the universe of motion, in all of its detail. The universe as thus defined is rational, logical, and *understandable*. The fact that some of its magnitudes cannot be represented graphically in the manner to which scientists have been accustomed merely indicates that previous ideas as to the basic nature of these magnitudes are erroneous.

DIMENSIONS IN THE UNIVERSE OF MOTION

In my publications I have followed a general policy of not duplicating material that is readily available in the textbooks, in order to conserve space for the new ideas that I am presenting. I therefore do not define terms that are in general use, commenting on the usage only where I have introduced some new concept, or have modified the meaning of a term. There was some confusion about my usage of the term “direction” originally, and I had occasion to discuss this matter in some of my publications. (See, for instance, *Nothing But Motion*, p. 48). These explanations apparently took care of the problem, as I have heard nothing about directions lately. It now appears that some misunderstandings also exist with respect to my use of the term “dimension.” Some comments on the usage of this term may therefore be helpful.

The dimensional situation is complicated by the fact that I necessarily have to use the term in its broadest sense, whereas it is more generally used with a very restricted meaning. From the general standpoint, “dimension” is a mathematical term that may be, but is not necessarily, capable of being represented in geometric form. An n -dimensional quantity is simply one that requires n independent numbers for definition. As one dictionary says, by way of illustration, “ a^2b^2c is a term of five dimensions.” Within a certain limited range, dimensions of space may be represented in the conventional reference system, and because this usage is so common, the qualification “spatial” is commonly omitted. Thus we say that a cube is three-dimensional, meaning that it extends into three vectorial dimensions of space. But we also say that space is three-dimensional, and here we mean something different. We do not mean that space extends into three dimensions of space. That statement is an absurdity. What we mean is that three scalar magnitudes, or numbers are required in order to define a location in space.

The space of the conventional reference system is three-dimensional. But it takes all three of these spatial dimensions to represent one dimension of motion in space. Consequently, the present-day physicist, who does not recognize the existence of anything outside the reference system, deal only with one dimension of motion. The prevailing opinion, therefore, is that all real motion can be represented geometrically in the reference system. Where the theorists have to resort to multiple dimensions in order to explain some of the more difficult experimental results, an expedient that has become quite common since observation and measurement have penetrated into the smaller, faster, and more distant regions of the universe, they portray the extra dimensions as in some way unreal. Heisenberg, for example, characterizes the atom as existing in an “abstract multidimensional space,” whatever that means.

My finding is that the real physical universe extends beyond the one dimension of motion represented in the reference system. What I have done is to take the physicists' vague idea of multiple dimensions, and put it into concrete form. This was the key to the development of a complete and consistent physical theory. One of the requirements for a full understanding of that theory is a recognition that the dimensions of motion are mathematical. When I refer to dimensions in my works, this term has no geometrical connotations, except where so specified. Dimensions are scalar magnitudes, just numbers. Different phenomena involve different numbers of independent magnitudes. It follows

that the number of dimensions with which we are concerned depends on the particular phenomenon with which we are dealing.

The first unit of motion, from the spatial zero to unit speed, the speed of light, is one-dimensional in space. The second unit is one-dimensional in time, but because we base our reference system on a spatial speed of zero, it appears in that reference system as a dimension of motion in space plus a dimension of motion in time (to the extent that the reference system can respond to motion in time) from an inverse speed of unity to the temporal zero. On this linear basis, there are two dimensions of motion between zero spatial motion and zero temporal motion; that is, it takes two numbers, one representing the quantity of motion in space and one representing the quantity of motion in time, to express the total magnitude of the motion difference between these two zero levels. Here, then, in this simple situation, we already have a case where the number of dimensions is either one or two, depending on the nature of the phenomenon with which we are dealing; that is, whether it is something that we refer to a zero base, or something that is necessarily referred to the natural base at unity. This is not all. Further dimensions may be introduced into the same situation because the one-dimensional motion that I have been describing can be distributed over three dimensions, in a manner similar to the way in which radiation from a light source is distributed. This does not change the one-unit magnitude, as the cube of one is still one. But if the two-unit magnitude is so distributed it extends to $2/3$, or 8, dimensions.

Inasmuch as our base is the spatial zero, a speed of three units adds a second dimension of motion in space to the two-unit combination. The result, three units of speed equivalent, measured from the spatial zero, is equal to three units of inverse speed equivalent, measured from the temporal zero. Beyond this neutral level, the motion as a whole converts to motion in time. But as long as the total speed remains below the neutral level, any motion in time that may exist acts as a modifier of the magnitude of the motion in space, rather than causing an actual change of position in time. This is easily understood on a mathematical basis. If a small negative number is added to a larger positive number, the result is simply a reduction in the magnitude of the positive number. The second dimension of motion is thus a motion in the spatial equivalent of time.

From the foregoing it can be seen that there are six dimensions of motion between the spatial zero and the temporal zero. The basic fact is that the universe is three-dimensional. Beyond this, the number of dimensions that have to be taken into consideration depends on the particular feature of the universe with which we are dealing. Of course, all this is very complicated compared to a simple three-dimensional coordinate system, and many individuals would like to put it into some simpler form. But we are dealing with nature, and nature does not accommodate itself to our preferences. Physical theory claims to be able to deal with all of the modern discoveries without going beyond the one dimension of motion that can be represented in a spatial coordinate system. Conventional physics has found it necessary to place the small-scale phenomena of the physical universe in a strange half-world, the “abstract multidimensional space” that Heisenberg refers to, a world that is populated by “virtual” particles and other entities that admittedly do not “exist objectively.” These ghostly denizens of the phantom sector of the physicists’ universe do not obey the normal physical laws or the rules of logic, and

are governed by mysterious “forces” of which there is no physical evidence. When all this is taken into consideration, it can easily be seen that I am not increasing the complexity of physical theory. I am merely taking the metaphysical ideas that are too vague to be useful in practice, and putting them into concrete form. The universe is, in fact, complex, and if we want to understand it we will have to meet it on its own terms.

STEP-BY-STEP

*An outline of the logical development of the basic
features of the Reciprocal System of theory*

Dewey B. Larson

Preface

Section A - Fundamentals

Section B - Direct Consequences

Section C - Simple Harmonic Motion

Section D - Rotational Motion

Section E - Varieties of Matter

Section F - Sub-Atomic Particles

Section G - Motion in Time

Conclusion

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 development 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 theoretical 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 A. 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.

Section A

Fundamentals

The concept on which the theoretical system is based is that of a universe of motion; one in which *everything is a manifestation of motion*. This concept, together with certain assumptions as to the nature and characteristics of the motion, is expressed in the following postulates:

First Fundamental Postulate

The physical universe is composed entirely of one component, motion, existing in three dimensions, in discrete units, and with two reciprocal aspects, space and time.

Second Fundamental Postulate

The physical universe conforms to the relations of ordinary commutative mathematics, its magnitudes are absolute, and its geometry is Euclidean.

In order to avoid any misunderstandings as to how the language of these postulates should be interpreted, the following points should be noted:

1. The term “motion” as used in the postulates refers to what may be called the scientific concept of motion, which is defined as a relation between space and time, and measured as speed or velocity. In its simplest form, the “equation of motion”, which expresses this definition in mathematical symbols, is $v = s/t$.
2. This scientific concept implies a continuous change with respect to any reference system that is not in motion (as thus defined). The result of this change is to alter the values of space (s) and time (t) in the equation of motion, when these values are expressed in relation to the stationary system of reference.
3. The entire development is based on this concept, not on the name "motion". Any other ideas as to what “motion” is, or ought to be, are completely irrelevant, as they do not enter into the development in any manner.
4. The basic postulate of the theoretical system asserts the existence of motion. In itself, without qualification, this would permit the existence of any conceivable kind of motion, but the additional assumptions included in the other postulates act as limitations on the types of motion that are permissible. The net result of the basic postulates plus the limitations is therefore to assert the existence of any kind of motion that is not excluded by the limiting postulates. We may express this point concisely by saying that anything which *can* exist *does* exist.
5. Inasmuch as it has been postulated that motion, as defined in the foregoing paragraphs, is the *sole* constituent of the physical universe, it follows from [Item 4](#) that all that is necessary in order to arrive at a full description of physical phenomena is to determine the *kinds of motion* that can exist, and the nature of the *possible changes in these motions*.

6. All of the information required for this purpose is implicit in the postulates, by definition. A development of the consequences of the postulates therefore defines a complete theoretical universe.

Section B

Direct Consequences

There are certain significant points of a general nature that are immediate and direct consequences of the postulates. Before starting to develop the more complex and specialized lines of thought leading to the relationships in particular areas, we will take note of these general items.

1. Neither space nor time has any independent existence. Each exists only in association with the other as motion.
2. But even though space and time do not actually exist independently, we can isolate the space aspect or the time aspect of a particular motion, or type of motion, and deal with it on a theoretical basis as if it were independent. (This is the same thing that we are doing in scientific practice when we work with such things as density, viscosity, *etc.*, even though they have no real existence, and are only relations between certain realities).
3. All units of space (or time) are alike, since each unit is equivalent to a unit of time (or space).
4. The only feature of either space or time that enters into the equation of motion is the numerical value. The reciprocal relation is therefore a general relation. Space and time are indistinguishable, except for the fact that one is the reciprocal of the other.
5. For this reason, the properties of one are likewise properties of the other.
6. Time, as well as space, is three-dimensional.
7. More space in any physical phenomenon is equivalent to less time, and vice versa.
8. For every physical phenomenon, there is another phenomenon which is an exact duplicate, except that space and time are interchanged.
9. Motion can take place in time as well as in space.
10. One of the kinds of motion that is possible within the limitations is uniform translational motion in a straight line.
11. Each unit of this motion involves a unit of space and a unit of time. For convenience, let us call these units *absolute locations* in space and time respectively, and let us call the combination of a location in space and a location in time, a location in space-time. Inasmuch as a single unit of space is the reciprocal of, and therefore equivalent to, a single unit of time, it follows that when a motion at unit speed has continued for a time x (that is, the absolute location in time has moved forward x units in the context of a stationary reference

system), the corresponding absolute location in space has also moved forward (outward in the direction of greater values) x units.

12. The foregoing applies to *every* absolute location in space-time, and we can therefore say that each such location is progressing outward away from all other locations at unit speed. The basic framework of a universe of motion is thus continually expanding (with respect to a stationary system of reference) in a manner analogous to the expansion of a balloon that is being inflated.
13. We will call the uniform increase in space and time, with respect to a stationary reference system, that takes place at unit speed the *progression* of space and time, respectively. When both are to be considered together, we will speak of the *progression of space-time*. Every location in space-time, and consequently every object that occupies such a location, is subject to the progression. The progression of space-time is therefore one of the basic motions (or forces) that determine the course of physical events.
14. Even though space and time exist only in discrete units, according to the postulates, the progression is a continuous process, not a succession of jumps, and there is progression even within the units, simply because these are units of progression, or motion. Consequently, specific points within the unit--the midpoint, for example--can be *identified*, even though they do not exist independently. As an analogy, we may consider a chain. Although the chain exists only in discrete units, or links, we can distinguish various portions of a link. For instance, if we utilize the chain as a means of measurement, we can measure $10\frac{1}{2}$ links, even though a half link would not qualify as part of the chain.
15. If nothing other than the continuous expansion existed, the universe would be merely a featureless uniformity. In order that there may be *physical phenomena* that can be observed or measured, there must be some deviation from this one-to-one space-time relation, and since it is the *deviation* that is observable, the amount of the deviation is a measure of the magnitude of the phenomenon. The omnipresent expansion at unit speed therefore constitutes the *natural reference system*, the datum from which all physical phenomena extend.

NOTE: This is a significant point. We are accustomed to relating physical phenomena to a stationary frame of reference. If an object has no capability of independent motion, so that it must remain in its original location unless acted upon by some outside agency, it has been assumed that this means the same location with respect to a stationary reference system. But, there is no reason why nature must necessarily conform to the current beliefs of the human race, and the foregoing statement of the implications of the fundamental postulates shows that a universe of motion, of the kind specified in those postulates, does *not* so conform. The *natural* system of reference for such a universe is an expanding system in which each location is moving outward from all others at unit speed. On this basis, an object with no independent motion does not remain at rest with respect to a stationary reference system, but moves outward at unit speed. The stationary reference system to which motion is customarily related is not a *natural* datum.

16. A stationary three-dimensional system of reference may be defined, either in the theoretical system or in the actual physical universe, by arbitrarily assuming some location or physical feature to be stationary. For most everyday purposes, positions are referred to the surface of the earth in the immediate vicinity. Where it is necessary to take the rotation of the Earth into account, the Earth's center is assumed to be motionless. For some astronomical purposes, the sun is taken as the stationary point of reference, while in other applications, the astronomers utilize the center of the Galaxy. In this work, the term “location” (as distinguished from “absolute location”) will be used to designate position with reference to some stationary system of this kind.
17. Inasmuch as the space progression is simply outward, without any inherent direction, its direction with respect to any stationary system of reference is determined by chance. If a location y with reference to a stationary, three-dimensional coordinate system is in coincidence with absolute location Y at a given point in the progression, then when x additional units of time have elapsed, absolute location Y will have moved x units of space outward from location y , and will be somewhere on the surface of a sphere centered at y .
18. Representation of changes in absolute location in a three-dimensional reference system is limited to translational motion and to the translational effects (if any) of other types of motion.
19. Since the movement of the absolute locations, as seen in the context of a stationary reference system, is linearly outward without any other qualification, except that imposed by the reference system, the amount of this movement is inherently a *scalar* quantity. It becomes a vector quantity—that is, it acquires a direction—only by virtue of its relation to the stationary reference system.
20. In current practice, the change of position resulting from motion is expressed in terms of *displacement*, a vector quantity. In this work, we will be dealing, to a large extent, with changes of position that are either inherently scalar, as indicated in Item 19, or cannot be represented in a three-dimensional coordinate system. For this reason, we will use the terms “movement” and “change of position”, and will not employ the term “displacement” in this sense. This term will, however, be utilized in a totally different application, which will be explained later.

Section C

Simple Harmonic Motion

All of the statements in Section B, aside from those dealing with the terminology utilized in this work, can be deduced directly from the postulates. Hereafter, the deductions will be cumulative; that is, each statement may be a consequence, wholly or in part, of some conclusion or conclusions previously stated.

1. While the progression is normally outward (positive), it is possible, within the limits imposed by the postulates, for certain motions to take place in the inward (negative) scalar direction. One such possibility is a single negatively directed unit of translational motion. This makes possible the existence of *simple harmonic motion*, in which the scalar direction of movement reverses at the end of a unit of space, or time. In such motion, each unit of space is associated with a unit of time, as in unidirectional translational motion, but in the context of a stationary, three-dimensional spatial (or temporal) reference system, the motion oscillates back and forth over a single unit of space (or time), and from the standpoint of such a system of reference, this is a vibratory motion in which one unit of space (or time) is associated with n units of time (or space).
2. At this stage of the development, no mechanism is available whereby *changes* can take place, and only continuous processes are possible. At first glance, therefore, it might appear that the reversals of scalar direction at each end of the basic unit are inadmissible. However, the changes of direction in simple harmonic motion are actually continuous, as can be seen from the fact that such motion is a projection of circular motion on a diameter. The algebraic sum of the positive and negative motions varies continuously from $+1$ at the midpoint of the forward movement to zero at the positive end of the path of motion, and then to -1 at the midpoint of the reverse movement and zero at the negative end of the path.
3. As indicated in Section B, the inherent scalar direction (positive or negative) of a motion in space (or in time) has a direction with reference to any stationary coordinate system, a *vectorial direction*, we may call it. This vectorial direction is independent of the scalar direction, except to the extent that the same factors may, in some instances, affect both. As an analogy, we may consider a motor car. The motion of this car has a direction in three-dimensional space, while at the same time, it has a scalar direction, in that it will be moving either forward or backward. As a general proposition, the vectorial direction of this vehicle is independent of its scalar direction. The car can run forward in any vectorial direction, or backward in any direction. However, if it is traveling on a very narrow road, and going forward when it moves south, then it must reverse the scalar direction and travel backward in order to move north. Similarly, the simple harmonic motion reverses both the scalar and the vectorial directions at each end of its one-unit path. This unit of space (or time) therefore remains stationary in the dimension of the motion when viewed in the context of a stationary three-dimensional coordinate system.

4. But the linear motion of the vibrating unit has no component in the dimensions perpendicular to the line of oscillation, and the normal progression of space-time is therefore operative in these dimensions. The absolute location of the vibrating unit consequently moves outward at unit speed in a direction perpendicular to the line of vibration. The combination of a vibratory motion and a linear motion perpendicular to the line of vibration results in a path which has the form of a sine curve. The vectorial direction of the progression is purely a matter of chance, and if a substantial number of these vibrating units originate coincidentally, it will be observed that they move outward in all directions from the point of origin, traveling at unit speed, and following a wave-like path.
5. Inasmuch as the theoretical phenomena emerge from the development without labels it is necessary to *identify* the physical phenomenon corresponding to a theoretical derivation before the two can be compared. However, this identification is easily accomplished by comparing the characteristics of the physical and theoretical phenomena. In most cases, the correlation is obvious, and in any event, the verification of the identification is automatic, as any error will quickly show up as a discrepancy.
6. The identity of the physical counterpart of the theoretical vibrating unit is obvious. This unit is a *photon*. The process of emission and movement of the photons is *radiation*. The space-time ratio of the vibrations is the *frequency* of the radiation, and the unit outward speed of movement is the speed of radiation, more familiarly known as the *speed of light*.
7. One of the most difficult problems with respect to radiation has been to explain how it can be propagated through space without some kind of a medium. This problem has never been solved other than by what has been described as a "semantic trick"; that is, assuming, entirely *ad hoc*, that space has the properties of a medium. In the theoretical universe this problem does not arise, as the photon remains in the same absolute location in which it originates. With respect to the natural system of reference it *does not move at all*, and the movement that is observed in the context of a stationary reference system relative to the stationary system, not a movement of the photon itself.
8. Another serious problem has been to provide an explanation for the fact that the photon behaves in some respects as a particle, whereas in other respects it behaves as a wave. Here, again, there is no problem at all in the theoretical universe. The theoretical photon acts as a particle in emission or absorption because it *is* a particle (that is, a discrete unit). It travels as a wave because the combination of its own inherent oscillating motion and the forward progression of space-time has the form of a wave.

Section D

Rotational Motion

1. Another type of motion that is permitted by the postulates is rotation. Before such a motion can take place, however, there must exist something that can rotate; that is, there must be some identifiable unit that can be distinguished from the general progression. The photon is the only primary unit that meets this requirement, and simple rotation is therefore a rotation of the photon.
2. Rotation is motion in which there is a continuous change in vectorial direction. Unlike the situation in simple harmonic motion, however, the scalar direction of the simple rotation remains constant. To illustrate this point, let us return to the automobile analogy, and this time let us assume that the car is operating on a circular track. The vectorial direction of this car is continually changing as it moves around the circle, but its scalar direction is constant. If the car starts moving forward, it continues to move forward.
3. Inasmuch as vectorial direction is not an inherent property of a motion, rotation cannot be distinguished from translation on the natural basis. Adding a unit of rotational motion in the positive scalar direction (the direction of the normal progression) to the photon would therefore result in a continuation of the progression, rather than an actual rotation. Thus, the photon can rotate only in the negative scalar direction. In the automobile analogy, the equivalent statement would be that for some reason the car can only run backward around the circle.
4. A rotating photon is thus traveling backward along the line of progression, moving *inward* in space (or time).
5. The vectorial direction corresponding to this inward (negative) scalar direction, like the vectorial direction of the non-rotating photon, is a result of viewing the motion in the context of an arbitrary reference system, rather than an inherent property of the motion itself. The vectorial direction is therefore determined entirely by chance in both cases. However, the non-rotating photon remains in the same absolute location permanently (unless acted upon by an outside agency) and the direction determined at the time of emission is therefore permanent. The rotating photon, on the other hand, is continually moving from one absolute location to another as it travels back along the line of progression, and each time it enters a new location, the vectorial direction is redetermined by the chance process. Inasmuch as all directions are equally probable, the motion will be distributed uniformly over all directions in the long run. A rotating photon will therefore move inward toward *all* space (or time) locations other than the one that it happens to occupy momentarily.
6. Since space and time locations cannot be identified by observation, neither inward nor outward motion can be recognized as such. It is possible, however, to observe the changes in the relations between the moving units and other physical objects.

The photons of radiation, for instance, are observed to be moving outward from the emitting objects. Similarly, each rotating photon is moving toward all other rotating photons, by reason of the inward motion in space (or time) in which all participate, and the change in relative position in space can be observed. This second class of identifiable objects in the theoretical universe thus manifests itself to observation as a number of individual units which continually move inward toward each other.

7. As in the case of the photon, the identification is obvious. The rotating photons are *atoms*. Collectively they constitute *matter*, and the inward motion in all directions is *gravitation*.
8. In three-dimensional space, the fraction of the inward motion directed toward a unit area at distance d from an atom of matter is inversely proportional to the total area at that distance; that is, to the surface of a sphere of radius d . The effective portion of the total inward motion is therefore inversely proportional to d^2 . This is the *inverse square law* to which gravitation conforms.
9. On the basis of the foregoing, gravitation in the theoretical universe being developed from the postulates is not an action of one aggregate of matter on another. Each atom and each aggregate of atoms is pursuing its own course independently of all others, but because each observable unit is moving inward in space, it is moving toward all others, and this gives the appearance of a mutual interaction. However, if we examine the characteristics of the force that each atom or aggregate appears to be exerting upon the others, we find that this is a force of a very peculiar nature. The gravitational "force" acts instantaneously, without an intervening medium, and in such a manner that it cannot be screened off or modified in any way. These observed characteristics are so difficult to explain theoretically that most theorists have taken the rather unscientific stand that the observations must, for some reason, be wrong, and that notwithstanding the observational evidence to the contrary, the gravitational effect must be propagated through a medium, or something with the properties of a medium, at a finite velocity. It is particularly significant, therefore, that the theoretical characteristics of gravitation, as derived from the postulates, are in full agreement with the observations. Motions which are totally independent of each other will necessarily have just the kind of characteristics that are observed in gravitation.
10. In the foregoing paragraphs, it has been noted parenthetically that the gravitational motion may be regarded as a force. The relation between the two concepts can be illustrated by a simple example. Let us assume a motion x existing coincidentally with an equal and oppositely directed motion, y . In this case, we can either take the position that both motions exist and that one neutralizes the other, or we can say that there are two forces tending to *cause* motion, but that no motion results because the forces counterbalance each other.
11. As noted in items 5 and 6, gravitation may take place either in space or in time. When it acts in space, the atoms of matter continue to occupy random locations in time, and vice versa. In an observable aggregate of matter the atoms are therefore

widely dispersed in time even though they are contiguous in space. The inverse type of aggregate in which the atoms are contiguous in time, but widely dispersed in space, is unobservable.

12. In dealing with the magnitude of the gravitational effect, we will need to take into account this point that spatial locations have no independent existence. A spatial location is merely one aspect of a space-time location. Gravitation therefore moves the atoms of matter toward all *space-time* locations, even though the *inward* movement is limited to space. Because of the random locations in time, an aggregate of n units of motion occupies n widely dispersed locations in space-time. In the apparent interaction of an aggregate of n effective units of motion with one of m effective units, each of the n units is moving toward each of the m units, and the magnitude of the gravitational effect at unit distance will therefore be nm . The factors that necessitate the use of the term “effective” in the foregoing statement will make their appearance later in the development.
13. *All* matter is subject to gravitation by reason of the same thing that makes it matter; that is, the rotational motion of the atoms. Gravitation is therefore the second of the basic motions (or forces) that determine the course of physical events.
14. Each atom of matter is carried outward by one of these motions, the progression of the absolute location that it occupies, while coincidentally it is moving inward by reason of the other basic motion, the scalar effect of its rotation. The net resultant of the two opposing motions is determined by their relative magnitude. At the shorter distances, gravitation predominates, and in the realm of ordinary experience, all aggregates of matter are subject to net gravitational motions (or forces). But the motion of the progression is constant at unit speed, while the opposing gravitational motion is attenuated by distance in accordance with the inverse square law. At some distance, the *gravitational limit* of the aggregate of matter under consideration, the motions reach equality. Beyond this point, the net movement is outward, increasing toward the speed of light as the gravitational effect continues to decrease.
15. All aggregates of matter smaller than the largest existing units are under the gravitational control of larger aggregates; that is, they are within the gravitational limits of these larger units. Consequently they are not able to continue the outward movement that would take place in the absence of the larger bodies. The largest existing aggregates are not limited in this manner, and according to item 14, any two such aggregates that are outside their mutual gravitational limits will recede from each other at speeds increasing with distance. In the observed physical universe, the largest aggregates of matter are *galaxies*, and the behavior of these galaxies is in full agreement with the theoretical behavior of the largest aggregates of matter in the theoretical universe. Current scientific opinion explains the observed recession of the distant galaxies by the *ad hoc* assumption of a gigantic explosion which hurled the galaxies out into space at their present velocities. The necessity for any such highly questionable assumption, with its accompaniment of difficult questions of a collateral nature, such as what *caused*

the explosion, is eliminated by the theoretical finding that the galactic recession is a natural and logical result of the most basic properties of matter.

Section E

Varieties of Matter

In the preceding sections, we have considered both photons and atoms merely as general classes of objects. This is sufficient so far as the photons are concerned, as there are no individual differences in this class of objects other than in frequency. There is, however, a large amount of variability in the atoms of matter, and our next undertaking in the exploration of the theoretical universe of the Reciprocal System will be to examine the nature of this variability and the reason for its existence.

This investigation will be concerned largely with the *magnitudes* of the various motions involved, and some points concerning these magnitudes should be noted before proceeding with the development. As stated in [Section B](#), the natural datum, or reference level, for physical phenomena is unit speed, not zero. The true magnitude of any absolute quantity (one that is not arbitrarily related to some selected reference datum) is therefore the deviation from the unit value, rather than the mathematical total. In the case of the combinations of rotational motion that constitutes matter, the magnitudes with which we will be primarily concerned are the rotational speeds.

But inasmuch as we will be dealing with units of deviation from unit speed, rather than with speeds measured in the usual manner from the mathematical zero, it will be desirable to utilize some different terminology to avoid confusion. We will therefore refer to this deviation as a *displacement* of the space-time ratio from the normal unit value. When the speed, s/t , is $1/n$ we will say that there is a *displacement in time* (or "time displacement") of $n-1$ units. Conversely, when the speed is $n/1$, and n units of space are associated with each unit of time, we will say that there is a *displacement in space* (or "space displacement") of $n-1$ units. In this connection it should be noted that in the region of displacements in time (speed = $1/n$) a higher displacement value (a greater deviation from the unit speed that constitutes the natural datum) corresponds to a lower speed as customarily measured.

1. In the context of a stationary, three-dimensional reference system, coincident translational motion in more than one dimension is impossible, as each motion alters locations in a different manner, and such motion would result in the same absolute location occupying two or more different positions in the reference system. Rotational motion, on the other hand, does not alter the location in a reference system of this kind, and coincident rotational motion in all three dimensions is therefore possible.
2. It is not possible, however, for a one-dimensional object, such as a photon, to have rotational motions *of the same kind* in all three dimensions. Rotation of the photon cannot take place independently around the line of vibration as an axis. Such a rotation would be indistinguishable from no rotation at all. The photon may, however, rotate around its midpoint. One such rotation generates a two-

dimensional figure, a disk. Rotation of the disk around a diameter generates a three-dimensional figure, a sphere. Since no fourth dimension is available, this process cannot be continued farther. The basic rotation of the photon is thus two-dimensional.

3. With this two-dimensional rotation in existence, the photon may rotate around the third axis in the opposite scalar direction. This is a rotation *of* the sphere generated by the basic rotation. Since the two-dimensional rotation is distributed over all three dimensions, the additional rotation in the third dimension is not required for stability of the structure, and the total rotation of the atom therefore consists of a two-dimensional rotation of each photon, with or without an oppositely directed one-dimensional rotation. For convenience, we will refer to the one-dimensional rotation as *electric* rotation, and the two-dimensional rotation as *magnetic* rotation. At the present stage of development, there are no electric or magnetic forces in the structures under consideration, but the identification of "electric" with "one-dimensional" and "magnetic" with "two-dimensional" will be of advantage when electric and magnetic phenomena are introduced later in the development.
4. The speed of the electric rotation is independent of that of the magnetic rotation, except to the extent that probability considerations favor the magnetic rotation, and the speeds in the two magnetic dimensions are partially independent, inasmuch as this rotation may be distributed spheroidally rather than spherically. Consequently, there are a number of different combinations of rotational speeds, which give rise to corresponding differences in physical behavior: differences in the *properties* of the various rotational combinations, we may say. The theoretical universe thus contains many different kinds of atoms with different properties. These can be identified as the *chemical elements*, each element corresponding to a specific combination of rotations.
5. The number of such combinations that can actually exist is limited by the probability principles, the validity of which, in application to the theoretical universe, is specified in the postulates. The most significant limitation results from the principle that small numbers of units are more probable than large numbers.
6. Geometrical considerations indicate that two photons can rotate around the same central point without interference if the rotational speeds are the same, thus forming a double unit. For a given number of units of effective motion, such combinations result in lower displacement values, and the probability principles therefore give them precedence over single units with higher displacement values. All rotating units with sufficient net total displacements to enable forming double units therefore do so.
7. The electric rotations of the two photons of a double unit can, and therefore do, take place in different dimensions. Each such rotation involves only one photon. Similar independence of the magnetic rotations is not possible because each is distributed over all available dimensions. Each magnetic rotation therefore

- involves movement of both photons. As a result, a unit of magnetic rotation in an atom is equivalent to $2n^2$ units of electric rotation, where n is the effective magnetic displacement.
8. In the normal outward progression each unit of motion, $s/t = 1/1$, is succeeded by a similar $1/1$ unit, yet another, and so on, the total up to any specific point being n units. In a combination structure, involving a *series* of displacements, the sequence is $1/1, 1/2, 1/3, \dots, 1/n$, or the reciprocals of these values, $1/1, 2/1, 3/1 \dots n/1$. Here, n is the last unit, not the total, and in order to arrive at a total a summation of the individual values is required. To obtain the total electric equivalent of a magnetic displacement, we must similarly sum up the individual $2n^2$ terms.
 9. Since the simple motions that have been considered thus far are inherently scalar, addition of another displacement of the same kind of an existing displacement would simply alter the scalar magnitude, without changing the nature of the motion. In order that there may be motion *of* the original motion—rotation of a photon, for example—it is necessary for the added displacement to be of an opposing nature. We have previously noted that the basic two-dimensional rotation of the photon can be rotated in the opposite scalar direction, but this is possible only because the magnitude of the one-dimensional rotation is less than that of the two-dimensional rotation, and the *net* rotational displacement of the combination is still negative, as it must be to oppose the positive vibrational motion. This possibility is not open in the case of the original rotation of the photon, but the necessary dissimilarity between the vibration and the rotation can be attained by means of the divergence of displacements in space from displacements in time. A photon with a vibrational displacement in time can acquire a rotational displacement in space, and vice versa.
 10. For the present we will be dealing only with those atoms whose vibrational displacement is in space and whose net rotational displacement is in time. The terms "matter", without any qualification, will hereafter refer to aggregates of atoms of this nature. Where it is desired to differentiate specifically between this and the inverse type of matter, in which the displacement of the vibration is in time and the net displacement of the rotation is in space, we will use the term "ordinary matter".
 11. While we will include all rotational combinations with net rotational displacement in time under the classification "matter", we will hereby restrict the term "atom" so that it applies only to those combinations which include two rotating systems.
 12. Since the magnetic rotational displacement is numerically smaller than the equivalent electric displacement, it is correspondingly more probably, and the magnetic rotation consequently takes precedence over the electric rotation wherever both would otherwise be possible. It will therefore be appropriate to begin our identification of the specific rotational combinations by considering those which have no effective electric rotation.

13. If a unit of space displacement is added to a motion with n units of time displacement, the new unit and one of the time displacement units constitute a full unit of motion (displacement zero) and since every such unit is independent, according to the postulates, this new unit separates from the remainder, leaving a residue of $n-1$ units of time displacement. Adding space displacement is therefore the equivalent of subtracting time displacement, and vice versa.
14. A structure in which the rotation is limited to one unit of magnetic displacement may be represented by the symbol 0-0-0, where the first two numbers represent the displacements in the magnetic dimensions and the third represents the electric displacement. In accordance with the principle expressed in item 13, the one unit of rotational time displacement merely neutralizes the one unit of vibrational space displacement, and brings the new total to zero. The 0-0-0 structure is therefore the rotational equivalent of nothing at all: the *rotational base*, we will call it.
15. By the operation of probability, added units of magnetic displacement go alternately to the two magnetic dimensions. A second such unit therefore brings the structure up to $\frac{1}{2}$ - $\frac{1}{2}$ -0. As has been stated, we are restricting the term "atom" to those combinations with two rotating systems, which requires *effective* rotational displacements in both magnetic dimensions. The $\frac{1}{2}$ - $\frac{1}{2}$ -0 combination does not qualify as an atom under this definition. The question as to just what it actually is will be considered in [Section F](#).
16. The next combination, 2-1-0, is the first of the purely magnetic rotational combinations that qualifies as an element. As has been noted, each magnetic displacement unit is equivalent to $2n^2$ electric displacement units, and the total displacement of this atom above the rotational base, in electric equivalent, is 4 units.
17. Inasmuch as the electric displacement unit is the smallest rotational unit that exists, and therefore the smallest amount by which one rotational combination can differ from another, the possible combinations form a series in which the total equivalent electric displacement of each successive member is one unit greater than that of its predecessor. We will identify the position in this sequence as the *atomic number* of the element, and because the first two units of displacement have been excluded from the atomic classification, this atomic number can be described as the net total equivalent electric displacement, less two units. On this basis, the atomic number of the 2-1-0 combination is 2, and we will identify this structure as the element Helium.
18. The 2-1-0 combination is one unit above the rotational base in each magnetic dimension. Addition of another magnetic unit therefore requires 2×2^2 , or 8, equivalent units. The result is 2-2-0, atomic number 10, which we identify as the element Neon. Another magnetic addition produces 3-2-0, atomic number 18, the element Argon. Similar additions complete the series of *inert gases*, a group of elements whose distinctive properties results from the fact that these are the only chemical elements without effective rotation in the electric dimension.

Atomic Number Element Displacements

2	Helium	2-1-0
10	Neon	2-2-0
18	Argon	3-2-0
36	Krypton	3-3-0
54	Xenon	4-3-0
86	Radon	4-4-0

19. The reason why the series terminates at 4-4-0 rather than continuing on to higher values will emerge later in the development.
20. In view of the greater probability of the magnetic displacement, the role of the electric displacement is confined to filling in the gaps between the combinations listed in the foregoing table. For example, helium is followed by these four elements:

Atomic Number Element Displacements

3	Lithium	2-1-1
4	Beryllium	2-1-2
5	Boron	2-1-3
6	Carbon	2-1-4

21. The next combination in this sequence would be 2-1-5, but another factor enters into the situation at this point because electric rotation can take place with displacement in space as well as with displacement in time. As previously noted, the rotational displacement of the atom as a whole--that is, the net total displacement--must be in time in order to constitute rotation *of* the photon. But as long as the larger component of this total, the magnetic displacement, is in time, the smaller component can be in space. In this case, the addition of space displacement reduces the net total time displacement. The 7-unit net effective time displacement that corresponds to the structure 2-1-5 can therefore be attained in an alternate manner by adding 3 units of displacement in space to the 2-2-0 combination. To distinguish space displacements from time displacements, we will enclose the space values in parentheses. On this basis, the alternate 7-unit structure is 2-2-(3), and by reason of the greater probability of the smaller electric displacement, this structure exists in preference to 2-1-5.
22. The other members of the second half of the group of elements between helium and neon are subject to the same considerations, and this sequence is as follows:

Atomic Number Element Displacements

6	Carbon	2-2-(4)
7	Nitrogen	2-2-(3)
8	Oxygen	2-2-(2)
9	Fluorine	2-2-(1)

- 23.

24. The probabilities of the two possible structures are nearly equal for carbon, midway between the two inert gases, inasmuch as the electric displacement is 4 in both cases. This element can therefore take either structure, and it is shown in both tabulations.
25. Each of the other gaps between inert gas elements is similarly filled by a series of combinations in which there is an increasing electric displacement in time up to the midpoint of the series, followed by a decreasing electric displacement in space in conjunction with the next higher magnetic displacement. Availability of electric displacement in space, as a component of the rotational combinations, also permits the existence of an element below helium. This is hydrogen, atomic number 1, which has rotational displacements if 2-1-(1).
26. All of the foregoing conclusions with respect to the effect of probability are based on a consideration of the characteristics of the elements as they exist in isolation. When they are interacting with other elements, as in chemical compounds, additional probability factors may be involved, and the net effect of all of the probability factors may be involved, and the net effect of all of the probability factors may favor some combination other than that which would exist if no external forces may be to favor 2-1-5 rather than 2-2-(3), or 2-2-(5) rather than 2-1-3.

Section F

Sub-Atomic Particles

1. From the points developed in [Section E](#) it is evident that between the rotational base 0-0-0 and the first of the atoms 2-1-(1) there are a number of possible combinations of rotations. We will identify these as the *sub-atomic particles*.
2. On this basis, the sub-atomic particles are not *constituents* of atoms, as viewed by current physical theory. They are *incomplete* atoms; that is, they are rotational combinations which do not have enough net total time displacement to form the two rotating systems that are required by the definition of an atom previously stated.
3. The electric rotation in these sub-atomic structures is identical with that in the atoms, but the magnetic rotational unit is only half as large, as it applies to only one rotating system. In these structures, the electric equivalent of the magnetic rotation is therefore n^2 , rather than $2n^2$, and since $n=1$ in all of the sub-atomic particles, the magnetic rotational unit is equal to the electric rotational unit.
4. The possible sub-atomic combinations with no electric rotation are the rotational base, 0-0-0, and the $\frac{1}{2}$ - $\frac{1}{2}$ -0 structure, which we identify as the *muon neutrino*.
5. Each of these magnetic combinations may add one unit of electric displacement, which may be either in space or in time. The additions to the rotational base produce 0-0-(1), which we identify as the *electron*, and 0-0-1, which we identify as the *positron*.
6. The positron is essentially nothing but a rotating unit of time displacement, and is therefore readily absorbed by any atom, since the atom of ordinary matter is a combination of motions of this same kind—rotations with net displacement in time. The electron, on the other hand, is a rotating unit of space displacement, and the ability of atoms of ordinary matter to utilize space displacement is severely limited. The theoretical result is a scarcity of positrons and an abundance of electrons in the material sector of the universe. This agrees with the observed situation.
7. Addition of electric displacement in space to the muon neutrino results in $\frac{1}{2}$ - $\frac{1}{2}$ -(1), which we identify as the *electron neutrino*. This combination has a net effective displacement of zero, and it is therefore a very elusive particle, but it does play an important part in some of the phenomena that will appear later in the development.
8. Addition of electric displacement in time to the muon neutrino would produce $\frac{1}{2}$ - $\frac{1}{2}$ -1. It is more probable that this will form a double rotating system, 1-1-(1), and this combination is identified as the *proton*.

Summary of Sub-Atomic Particles

Particle	Displacements
Electron	0-0-(1)
Rotational Base	0-0-0
Positron	0-0-1
Electron Neutrino	$\frac{1}{2}$ - $\frac{1}{2}$ -(1)
Muon Neutrino	$\frac{1}{2}$ - $\frac{1}{2}$ -0
Proton	1-1-(1)

Section G

Motion in Time

1. When the uniform outward motion at unit speed that constitutes the natural reference datum of the physical universe is modified by a displacement of the space-time ratio from a normal unit value, the resulting speed is either $1/n$ or $n/1$. A speed such as n/m is excluded for reasons set forth in item [E-13](#).
2. If the displacement is in time, the speed is $1/n$, and in this case the change in spatial location due to the motion is less than that which takes place at unit speed, whereas the change in temporal location remains the same as at unit speed. From the standpoint of the natural reference system, therefore, this motion has resulted in a change of position in space. We may thus say that motion at speeds less than unity is *motion in space*.
3. Inasmuch as the limiting value of the quantity $1/n$ is $1/1$, or unity, it follows that motion in space cannot take place at speeds greater than unity (the speed of light). This agrees with observation, but in interpreting the observations it has hitherto been assumed that *all* motion takes place in space, and on this basis, it has been concluded that *no* motion can take place at a speed greater than that of light. According to the present findings, this conclusion is incorrect.
4. It is generally believed that the conclusion as to the impossibility of exceeding the speed of light has been proved by experiment. The truth is, however, that the experiments have all involved acceleration of particles by electromagnetic forces, and what the results of these experiments actually show is not that speeds in excess of that of light are impossible, but that they cannot be produced *by means of forces of this kind*. As will be seen later in the development, the deductions from the postulates arrive at this same conclusion, but they also show that this does not preclude production of higher speeds by other means, specifically the release of large concentrations of energy by explosive processes.
5. From the reciprocal relation between space and time, it follows that the statements in item 2 are also applicable in the inverse manner; that is, motion can take place at speeds greater than unity ($v = n/1$) but motion at such speeds results in change of position in time. It is *motion in time*, rather than motion in space.
6. The limiting value of the quantity $n/1$ is $1/1$, or unity. Motion in time therefore cannot take place at speed *less* than that of light.
7. We will now want to recognize that when the equation of motion is expressed in the form $v = s/t$, it is an *equation of motion in space*. If stated in terms of velocity, v and s are vector quantities, while t is a scalar quantity.
8. In the inverse form, the equation is $e = t/s$, where e and t are vector quantities, when the equation is stated in vector form, and s is a scalar quantity. This is an *equation of motion in time*.

9. If we begin with a speed $1/n$ approximating zero, and add successive increments of space displacement, the result is an increase in speed as the time displacement $n-1$ is gradually neutralized by the addition of space displacement. This continues until unit speed is reached. In the inverse situation, beginning with unit speed, further additions of the same kind go into a direct increase of the space displacement, reducing the inverse speed until that quantity finally reaches the vicinity of zero. Addition of successive increments of time displacement to any existing speed similarly moves it in the opposite direction, toward zero spatial speed.
10. When the speed is negligible in comparison with the speed of light, the value of t in the equation of motion in space is the same as that applicable to the object such as a photon that has no motion at all in the natural reference system. The magnitude of this quantity (in relative terms) can be determined by observation of any repetitive physical process of a uniform nature. Such a process, or the object in which the process is taking place, is called a *clock*, and the time thus measured is *clock time*. This clock time is the time of the progression, the time which corresponds to motion at the speed of light.
11. At very low speeds or velocities, the relative speed or velocity is the sum, or vector sum, of the individual values, inasmuch as the paths of the progression in time for the two objects are essentially coincident. For speeds a and b in opposite directions, the relative speed is $a+b$.
12. At speeds significantly above zero the moving object travels a distance of s' in clock time t . By reason of the equivalence of the unit of space and the unit of time, it also moves an amount t' in time equivalent to s' , independently of the time of the progression, and this additional time t' must be taken into account in determining relative speeds or velocities. For example, if a photon is emitted from a stationary source, the relative speed is $1+0=1$. If it is emitted from an object moving with speed ' a ' in the direction opposite to that in which the photon is moving, the space separation at the end of one unit of clock time is $1+a$. But the moving object has also traveled an equivalent distance a in time, so that the time separation between the photon and the emitting object is now also $1+a$. The relative speed is $1+a$ divided by $1+a$, or unity.
13. The absolute speed of light is unity—one unit of space per unit of time—by reason of the postulated reciprocal relation between the two units. It now follows from item 11 that the speed of light (or any other radiation) relative to *any* reference datum is also unity. This is the relationship demonstrated by the Michelson-Morley experiment, and postulated by Einstein as the principal basis of his special theory of relativity. In the theoretical universe of the Reciprocal System, it is not a postulate but a *deduction* from the general postulates of the theory.
14. The inaccuracies due to the use of uncorrected clock time in applications involving high speeds are the essence of the problem that led to Einstein's formulation of the special theory, and the lack of recognition of the true nature of

the problem is the reason why it has not been possible to extend this restricted theory to motion in general.

Concluding Remarks

The objective of this work is not to develop the new theoretical structure in detail—that has already been done in previous publications—but to bring out more clearly the general *nature* of the development. Actually it should not be difficult to follow a deductive chain of thought consisting of a series of statements in the form, “given A and B, then C necessarily follows,” but the unfamiliar character of many of the derived concepts evidently creates difficulties for some of those who wish to examine the theory in detail, and obscures the inherent simplicity of the step-by-step development. What this work is undertaking to do is to identify those steps—the conclusions that necessarily follow from what has gone before—and to show them in their proper sequence.

Just how far it is necessary to go in order to clarify the points at issue is somewhat uncertain, but it would seem that anyone who follows the deductive development as far as it has been carried herein should have no difficulty in seeing that it can be extended almost indefinitely in the same manner.

THE DIMENSIONS OF MOTION

Now that the existence of scalar motion has been demonstrated, it will be appropriate to examine the consequences of this existence. Some of the most significant consequences are related to the dimensions of this hitherto unrecognized type of motion. The word “dimension” is used in several different senses, but in the sense in which it is applied to space it signifies the number of independent magnitudes that are required for a complete definition of a spatial quantity. It is generally conceded that space is three-dimensional. Thus three independent magnitudes are required for a complete definition of a quantity of space. Throughout the early years of science this was taken as an indication that the universe is three-dimensional. Currently, the favored hypothesis is that of a four-dimensional universe, in which the three dimensions of space are joined to one dimension of time.

Strangely enough, there does not appear to have been any critical examination of the question as to the number of dimensions of motion that are possible. The scientific community has simply taken it for granted that the limits applicable to motion coincide with those of the spatial reference system. On reviewing this situation it can be seen that this assumption is incorrect. The relation of any one of the three space magnitudes to a quantity of time constitutes a scalar motion. Thus three dimensions of scalar motion are possible. But only one dimension of motion can be accommodated within the conventional spatial reference system. The result of any motion within this reference system can be represented by a vector (a one-dimensional expression), and the resultant of any number of such motions can be represented by the vector sum (likewise one-dimensional). Any motions that exist in the other two dimensions cannot be represented.

Here again we encounter a shortcoming of the reference system. In our examination of the nature of scalar motion we saw that this type of motion cannot be represented in the reference system in its true character. The magnitude and direction attributed to such a motion in the context of the reference system are not specifically defined, but are wholly dependent on the size and position of the object whose location constitutes the reference point. Now we find that there are motions which cannot be represented in the reference system in any manner. It is therefore evident that the system of spatial coordinates that we use in conjunction with a clock as a system of reference for physical activity gives us a severely limited, and in some respects inaccurate, view of physical reality. In order to get the true picture we need to examine the whole range of physical activity, not merely that portion of the whole that the reference system is capable of representing.

For instance, gravitation has been identified as a scalar motion, and there is no evidence that it is subject to any kind of a dimensional limitation other than that applying to scalar motion in general. We must therefore conclude that gravitation can act three-dimensionally. Furthermore, it can be seen that gravitation must act in all of the dimensions in which it can act. This is a necessary consequence of the relation between gravitation and mass. The magnitude of the gravitational force exerted by a material particle or aggregate (a measure of its gravitational motion) is determined by its mass. Thus mass is a measure of the inherent negative scalar motion content of the matter. It

follows that motion of any mass m is a motion of a negative scalar motion. To produce such a compound motion, a positive scalar motion v (measured as speed or velocity) must be applied to the mass. The resultant is mv , now called momentum, but known earlier as “quantity of motion,” a term that more clearly expresses the nature of the quantity. In the context of a spatial reference system, the applied motion v has a direction, and is thus a vector quantity, but the direction is imparted by the coupling to the reference system and is not an inherent property of the motion itself. This motion therefore retains its positive scalar status irrespective of the vectorial direction.

In the compound motion mv the negative gravitational motion acts as a resistance to the positive motion v . The gravitational motion must therefore take place in all three of the available dimensions, as any one of the three may be parallel to the dimension of the reference system, and there would be no effective resistance in any vacant dimension. We may therefore identify the gravitational motion as three-dimensional speed, which we can express as s^3/t^3 , where s and t are space and time respectively. The mass (the resistance that this negative gravitational motion offers to the applied positive motion) is then the inverse of this quantity, or t^3/s^3 . Since only one dimension of motion can be represented in a three-dimensional spatial coordinate system, the gravitational motion in the other two dimensions has no directional effect, but its magnitude applies as a modifier of the magnitude of the motion in the dimension of the reference system.

We now turn to a different kind of “dimensions.” When physical quantities are resolved into component quantities of a fundamental nature, these component quantities are called dimensions. The currently accepted systems of measurement express the dimensions of mechanical quantities in terms of mass, length and time, together with the dimensions, in the first sense, of these quantities. But now that mass has been identified as a motion, a relation between space and time, all of the quantities of the mechanical system can be expressed in terms of space and time only. For purposes of the present discussion the word “space” will be used instead of “length,” to avoid implying that there is some dimensional difference between space and time. On this basis, the “dimensions,” or “space-time dimensions” of one-dimensional speed are space divided by time, or s/t . As indicated above, mass has the dimensions t^3/s^3 .

The product of mass and speed (or velocity) is $t^3/s^3 \times s/t = t^2/s^2$. This is “quantity of motion,” or momentum. The product of mass and the second power of speed is $t^3/s^3 \times s^2/t^2 = t/s$, which is energy. Acceleration, the time rate of change of speed, is $s/t \times 1/t = s/t^2$. Multiplying acceleration by mass, we obtain $t^3/s^3 \times s/t^2$, which is force, the “quantity of acceleration,” we might call it. The dimensions of the other mechanical quantities are simply combinations of these basic dimensions. Pressure, for instance, is force divided by area, $t/s^2 \times 1/s^2 = t/s^4$.

When reduced to space-time terms in accordance with the foregoing identifications, all of the well-established mechanical relations are dimensionally consistent. To illustrate this agreement, we may consider the relations applicable to angular motion, which take a different form from those applying to translational motion, and utilize some different physical quantities. The angular system introduces a purely numerical quantity, the angle of rotation q . The time rate of change of this angle is the angular velocity w , which has the dimensions $w = q/t = 1/t$. Force is applied in the form of torque, L , which is the

product of force and the radius, r . $L = Fr = t/s^2 \times s = t/s$. One other quantity entering into the angular relations is the moment of inertia, symbol I , the product of the mass and the second power of the radius. $I = mr^2 = t^3/s^3 \times s^2 = t^3/s$. The following equations demonstrate the dimensional consistency achieved by this identification of the space-time dimensions:

$$\text{energy (t/s)} = Lq = t/s \times 1 = t/s$$

$$\text{energy (t/s)} = 1/2I\omega^2 = t^3/s \times 1/t^2 = t/s$$

$$\text{power (1/s)} = L\omega = t/s \times 1/t = 1/s$$

$$\text{torque (t/s)} = 1/2I\omega^2 = t^3/s \times 1/t^2 = t/s$$

The only dimensional discrepancy in the basic equations of the mechanical system is in the gravitational force equation, which is expressed as $F = Gmm'/d^2$, where G is the gravitational constant and d is the distance between the interacting masses. Although this equation is correct mathematically, it cannot qualify as a theoretically established relation. As one physics textbook puts it, this equation "is not a defining equation... and cannot be derived from defining equations. It represents an observed relationship." The reason for this inability to arrive at a theoretical explanation of the equation becomes apparent when we examine it from a dimensional standpoint. The dimensions of force in general are those of the product of mass and acceleration. It follows that these must also be the dimensions of any specific force. For instance, the gravitational force acting on an object in the earth's gravitational field is the product of the mass and the "acceleration due to gravity." These same dimensions must likewise apply to the gravitational force in general. When we look at the gravitational equation in this light, it becomes evident that the gravitational constant represents the magnitude of the acceleration at unit values of m' and d , and that these quantities are dimensionless ratios. The dimensionally correct expression of the gravitational equation is then $F = ma$, where the numerical value of a is Gm'/d^2 .

The space-time dimensions of the quantities involved in current electricity can easily be identified in the same manner as those of the mechanical system. Most of the measurement systems currently in use add an electric quantity to the mass, length and time applicable to the mechanical system, bringing the total number of independent base quantities to four. However, the new information developed in the foregoing paragraphs enables expressing the electrical quantities of this class in terms of space and time only, in the same manner as the mechanical quantities.

Electrical energy (watt-hours) is merely one form of energy in general, and therefore has the energy dimensions, t/s . Power (watts) is energy divided by time, $t/s \times 1/t = 1/s$. Electrical force, or voltage (volts) is equivalent to mechanical force, with the dimensions t/s^2 . Electric current (amperes) is power divided by voltage. $I = 1/s \times s^2/t = s/t$. Thus current is dimensionally equal to speed. Electrical quantity (coulombs) is current multiplied by time, and has the dimensions $Q = It = s/t \times t = s$. Resistance (ohms) is voltage divided by current, $R = t/s^2 \times t/s = t^2/s^3$. This is the only one of the basic quantities involved in the electric current phenomena that has no counterpart in the mechanical

system. Its significance can be appreciated when it is noted that the dimensions t^2/s^3 are those of mass per unit time. The dimensions of other electrical quantities can be obtained by combination, as noted in connection with the mechanical quantities.

As can be seen from the foregoing, the quantities involved in current electricity are dimensionally equivalent to those of the mechanical system. We could, in fact, describe the current phenomena as the mechanical aspects of electricity. The only important difference is that mechanics is largely concerned with the motions of individual units or aggregates, while current electricity deals with continuous phenomena in which the individual units are not separately identified.

The validity of the dimensional assignments in electricity, and the identity of the electrical and mechanical relations, can be verified by reducing the respective equations to the space-time basis. For example, in mechanics the expression for kinetic energy (or work) is $W = \frac{1}{2}mv^2$, the dimensions of which are $t^3/s^3 \times s^2/t^2 = t/s$. The corresponding equation for the energy of the electric current is $W = I^2Rt$. As mentioned above, the product Rt is equivalent to mass, while I , the current, has the dimensions of speed, s/t . Thus, like the kinetic energy, the electrical energy is the product of mass and the second power of speed, $W = I^2Rt = s^2/t^2 \times t^2/s^3 \times t = t/s$. Another expression for mechanical energy is force times distance, $W = Fd = t/s^2 \times s = t/s$. Similarly, electrical energy is voltage times quantity, $W = VQ = t/s^2 \times s = t/s$. All of the other established relations of current electricity are likewise dimensionally consistent, and equivalent to the corresponding mechanical relations, when reduced to space-time terms.

Identification of the space-time dimensions of electrostatic quantities, those involving electric charge, is complicated by the fact that in present-day physical thought electric charge is not distinguished from electric quantity. As we have seen, electric quantity is dimensionally equivalent to space. On the other hand, we can deduce from the points brought out in the preceding chapter that electric charge is the one-dimensional analog of mass, and is therefore dimensionally equivalent to energy. This can be verified by consideration of the relations involving electric field intensity, symbol E . In terms of charge, the electric field intensity is given by the expression $E = Q/s^2$. But the field intensity is defined as force per unit distance, and its space-time dimensions are therefore $t/s^2 \times 1/s = t/s^3$. Applying these dimensions to the equation $E = Q/s^2$, we obtain $Q = Es^2 = t/s^3 \times s^2 = t/s$.

As long as the two different quantities that are called by the same name are used separately, their practical application is not affected, but confusion is introduced into the theoretical treatment of the phenomena that are involved. For instance in the relations involving capacitance (symbol C), $Q = t/s$ in the basic equation $C = Q/V = t/s \times s^2/t = s$. The conclusion that capacitance is dimensionally equivalent to space is confirmed observationally, as the capacitance can be calculated from geometrical measurements. However, the usual form of the corresponding energy equation is $W = QV$, reflecting the definition of the volt as one joule per coulomb. In this equation, $Q = W/V = t/s \times s^2/t = s$. Because of the lack of distinction between the two usages of Q , the quantity CV , which is equal to Q in the equation $C = Q/V$ is freely substituted for Q in equations of the $W = Q/V$ type, leading to results such as $W = C/V^2$, which are dimensionally incorrect.

Such findings emphasize the point that the ability to reduce all physical relations to their space-time dimensions provides us with a powerful and effective tool for analyzing physical phenomena. Its usefulness is clearly demonstrated when it is applied to an examination of magnetism, which has been the least understood of the major areas of physics. The currently accepted formulations of the various magnetic relations are a mixture of correct and incorrect expressions, but by using those that are most firmly based it is possible to identify the space-time dimensions of the primary magnetic quantities. This information then enables correcting the existing errors in the statements of other relations, and establishing dimensional consistency over the full range of magnetic phenomena.

In carrying out such a program we find that magnetism is a two-dimensional analog of electricity. The effect of the added dimension is to introduce a factor t/s into the expressions of the relations applicable to the one-dimensional electric system. Thus the magnetic analog of an electric charge, t/s , is a magnetic charge, t^2/s^2 . The existence of such a charge is not recognized in present-day magnetic theory, probably because there is no independent magnetically-charged particle, but one of the methods of dealing with permanent magnets makes use of the concept of a "magnetic pole," which is essentially the same thing. The unit pole strength in the SI system, the measurement system now most commonly applied to magnetism, is the weber, which is equivalent to a volt-second, and therefore has the dimensions $t/s^2 \times t = t^2/s^2$. The same units and dimensions apply to magnetic flux, a quantity that is currently used in most relations that involve magnetic charge, as well as in other applications where flux is the more appropriate term.

Current ideas concerning magnetic potential, or magnetic force, are in a state of confusion. Questions as to the relation between electric potential and magnetic potential, the difference, if any, between potential and force, and the meaning of the distinctions that are drawn between various magnetic quantities such as magnetic potential, magnetic vector potential, magnetic scalar potential, and magnetomotive force, have never received definitive answers. Now, however, by analyzing these quantities into their space-time dimensions we are able to provide the answers that have been lacking. We find that force and potential have the same dimensions, and are therefore equivalent quantities. The term "potential" is generally applied to a distributed force, a force field, and the use of a special name in this context is probably justified, but it should be kept in mind that a potential is a force.

On the other hand, a magnetic potential (force) is not dimensionally equivalent to an electrical potential (force), as it is subject to the additional t/s factor that relates the two-dimensional magnetic quantities to the one-dimensional electric quantities. From the dimensions t/s^2 of the electric potential, it follows that the correct dimensions of the magnetic potential are $t/s \times t/s^2 = t^2/s^3$. This agrees with the dimensions of magnetic vector potential. In the SI system, the unit of this quantity is the weber per meter, or $t^2/s^2 \times 1/s = t^2/s^3$. The corresponding cgs unit is the gilbert, which also reduces to t^2/s^3 .

The same dimensions should apply to magnetomotive force (MMF), and to magnetic potential, where this quantity is distinguished from vector potential. But an error has been introduced into the dimensions attributed to these quantities because the accepted defining relation is an empirical expression that is dimensionally incomplete.

Experiments show that the magnetomotive force can be calculated by means of the expression $MMF = nI$, where n is the number of turns in a coil. Since n is dimensionless, this equation indicates that MMF has the dimensions of electric current. The unit has therefore been taken as the ampere, dimensions s/t . From the discrepancy between these and the correct dimensions we can deduce that the equation $MMF = nI$, from which the ampere unit is derived, is lacking a quantity with the dimensions $t^2/s^3 \times t/s = t^3/s^4$.

There is enough information available to make it evident that the missing factor with these dimensions is the permeability, the magnetic analog of electrical resistance. The permeability of most substances is unity, and omitting has no effect on the numerical results of most experimental measurements. This has led to overlooking it in such relations as the one used in deriving the ampere unit for MMF. When we put the permeability (symbol μ) into the empirical equation it becomes $MMF = \mu nI$, with the correct dimensions, $t^3/s^4 \times s/t = t^2/s^3$.

The error in the dimensions attributed to MMF carries over into the potential gradient, the magnetic field intensity. By definition, this is the magnetic field potential divided by distance, $t^2/s^3 \times 1/s = t^2/s^4$. But the unit in the SI system is the ampere per meter, the dimensions of which are $s/t \times 1/s = 1/t$. In this case, the cgs unit, the oersted, is derived from the dimensionally correct unit of magnetic potential, and therefore has the correct dimensions, t^2/s^4 .

The discrepancies in the dimensions of MMF and magnetic field intensity are typical of the confusion that exists in a number of magnetic areas. Much progress has been made toward clarifying these situations in the past few decades, but active, and sometimes acrimonious, controversies still persist with respect to such quantities as magnetic moment and the two vectors usually designated by the letters B and H . In most of these cases, including those specifically mentioned, introduction of the permeability where it is appropriate, or removing it where it is inappropriate, is all that is necessary to clear up the confusion and attain dimensional validity.

Correction of the errors in electric and magnetic theory that have been discussed in the foregoing paragraphs, together with clarification of physical relations in other areas of confusion, enables expressing all electric and magnetic quantities and relations in terms of space and time, thus completing the consolidation of all of the various systems of measurement into one comprehensive and consistent system. An achievement of this kind is, of course, self-verifying, as the possibility that there might be more than one consistent system of dimensional assignments that agree with observations over the entire field of physical activity is negligible.

But straightening out the system of measurement is only a small part of what has been accomplished in this development. More importantly, the positive identification of the space-time dimensions of any physical quantity defines the basic physical nature of that quantity. Consequently, any hypothesis with respect to a physical process in which this quantity participates must agree with the dimensional definition. The effect of this constraint on theory construction is illustrated by the findings with respect to the nature of current electricity that were mentioned earlier. Present-day theory views the electric current as a flow of electric charges. But the dimensional analysis shows that charge has

the dimensions t/s , whereas the moving entity in the current flow has the dimensions of space, s . It follows that the current is not a flow of electric charges.

Furthermore, the identification of the space-time dimensions of the moving entity not only tells us what the current is not, but goes on to reveal just what it is. According to present-day theory, the carriers of the charges, which are identified as electrons, move through the spaces between the atoms. The finding that the moving entities have the dimensions of space makes this kind of a flow pattern impossible. An entity with the dimensions of space cannot move through space, as the relation of space to space is not motion. Such an entity must move through the matter itself, not through the vacant spaces. This explains why the current is confined within the conductor, even if the conductor is bare. If the carriers of the current were able to move forward through vacant spaces between the atoms, they should likewise be able to move laterally through similar spaces, and escape from the conductor. But since the current moves through the matter, the confinement is a necessary consequence.

The electric current is a movement of space through matter, a motion that is equivalent, in all but direction, to movement of matter through space. This is a concept that many individuals will find hard to accept. But it should be realized that the moving entities are not quantities of the space with which we are familiar, extension space, we may call it. There are physical quantities that are dimensionally equivalent to this space of our ordinary experience, and play the same role in physical activity. One of them, capacitance, has already been mentioned in the preceding discussion. The moving entities are quantities of this kind, not quantities of extension space.

Here, then, is the explanation of the fact that the basic quantities and relations of the electric current phenomena are identical with those of the mechanical system. The movement of space through matter is essentially equivalent to the movement of matter through space, and is described by the same mathematical expressions. Additionally, the identification of the electric charge as a motion explains the association between charges and certain current phenomena that has been accepted as evidence in favor of the "moving charge" theory of the electric current. One observation that has had considerable influence on scientific thought is that an electron moving in open space has the same magnetic properties as an electric current. But we can now see that the observed electron is not merely a charge. It is a particle with an added motion that constitutes the charge. The carrier of the electric current is the same particle without the charge. A charge that is stationary in the reference system has electrostatic properties. An uncharged electron in motion within a conductor has magnetic properties. A charged electron moving in a conductor or in a gravitational field has both magnetic and electrostatic properties. It is the motion of physical entities with the dimensions of space that produces the magnetic effect. Whether or not these entities—electrons or their equivalent—are charged is irrelevant from this standpoint.

Another observed phenomenon that has contributed to the acceptance of the "moving charge" theory is the emission of charged electrons from current-carrying conductors under certain conditions. The argument in this instance is that if charged electrons come out of a conductor there must have been charged electrons in the conductor. The answer to this is that the kind of motion which constitutes the charge is easily imparted to a

particle or atom (as anyone who handles one of the modern synthetic fabrics can testify), and this motion is imparted to the electrons in the process of ejection from the conductor. Since the uncharged particle cannot move through space, the acquisition of a charge is one of the requirements for escape.

In addition to providing these alternative explanations for aspects of the electric current phenomena that are consistent with the “moving charge” theory, the new theory of the current that emerges from the scalar motion study also accounts for a number of features of the current flow that are difficult to reconcile with the conventional theory. But the validity of the new theory does not rest on a summation of its accomplishments. The conclusive point is that the identification of the electric current as a motion of space through matter is confirmed by agreement with the dimensions of the participating entities, dimensions that are verified by every physical relation in which the electric current is involved.

The proof of validity can be carried even farther. It is possible to put the whole development of thought in this and the preceding article to a conclusive test. We have found that mass is a three-dimensional scalar motion, and that the electric current is a one-dimensional scalar motion through a mass by entities that have the dimensions of space. We have further found that magnetism is a two-dimensional analog of electricity. If these findings are valid, certain consequences necessarily follow that are extremely difficult, perhaps impossible, to explain in any other way. The one-dimensional, oppositely directed, flow of the current through the three-dimensional scalar motion of matter neutralizes a portion of the motion in one of the three dimensions, and should leave an observable two-dimensional (magnetic) residue. Similarly, movement of a two-dimensional (magnetic) entity through a mass, or the equivalent of such a motion, should leave a one-dimensional (electric) residue. Inasmuch as these are direct and specific requirements of the theory outlined in the foregoing paragraphs, and are not called for by any other physical theory, their presence or absence is a definitive test of the validity of the theory.

The observations give us an unequivocal answer. The current flow produces a magnetic effect, and this effect is perpendicular to the direction of the current, just as it must be if it is the residue of a three-dimensional motion that remains after motion in the one dimension of the current flow is neutralized. This perpendicular direction of the magnetic effect of the current is a total mystery to present-day physical science, which has no explanation for either the origin of the effect or its direction. But both the origin and the direction are obvious and necessary consequences of our findings with respect to the nature of mass and the electric current.

There is no independent magnetic particle similar to the carrier of the electric current, and no two-dimensional motion of space through matter analogous to the one-dimensional motion of the current is possible, but the same effect can be produced by mechanical movement of mass through a magnetic field, or an equivalent process. As the theory requires, the one-dimensional residue of such motion is observed to be an electric current. This process is electromagnetic induction. The magnetic effect of the current is electromagnetism.

On first consideration it might seem that the magnitude of the electromagnetic effect is far out of proportion to the amount of gravitational motion that is neutralized by the current. However, this is a result of the large numerical constant, 3×10^{10} in cgs units (represented by the symbol c), that applies to the space-time ratio s/t where conversion from an n -dimensional quantity to an m -dimensional quantity takes place. An example that, by this time, is familiar to all, is the conversion of mass (t^3/s^3) to energy (t/s). In that process, where the relation is between a three-dimensional quantity and a one-dimensional quantity, the numerical factor is c^2 . In the relation between the three-dimensional mass and the two-dimensional magnetic residue the numerical factor is c , less than c^2 but still a very large number.

Thus the theory of the electric current developed in the foregoing discussion passes the test of validity in a definite and positive manner. The results that it requires are in full agreement with two observed physical phenomena of a significant nature that are wholly unexplained in present-day physical thought. Together with the positively established validity of the corresponding system of space-time dimensions, this test provides a verification of the entire theoretical development, a proof that meets the most rigid scientific standards

THEORY OF SOLIDS

The objective of the project being undertaken by Professor Meyer and his associates is to test the validity of the explanation of the cohesion of solids derived from a development of the consequences of the fundamental postulates of the Reciprocal System of physical theory, the basic premise of which is that the physical universe is composed entirely of discrete units of motion.

In a universe having the properties specified in these postulates, the *natural* system of reference, the datum from which all physical activity extends, is not the stationary system to which such activity is ordinarily referred, but an expanding system in which each location is moving outward from all others at unit speed. The atoms of matter occupying such locations are carried outward by this movement of the space-time reference system. Coincidentally, they are moving in the opposite direction by reason of their gravitational motion. The term outward, in this connection, refers to the direction with respect to unit distance. Since the atoms are separated by less than unit distance in the solid state, the progression of the reference system moves them closer together, and their gravitational motion moves them farther apart. The gravitational effect decreases with distance, while the space-time progression remains unchanged, and an equilibrium is therefore reached at a definite distance, which depends on the magnitudes of the atomic rotations and on the relative orientation of the interacting atoms.

Where nothing exists but motion, as in the postulated universe, *every* physical entity or phenomenon is either some kind of a motion, a combination of motions, or a relation between motions. Development of the consequences of the fundamental postulates leads to the identification of atoms of matter as combinations of rotational motion in three dimensions, the nature of this motion being such that it has a scalar effect (gravitation) in opposition to the outward movement of the reference system. A certain minimum amount of such motion has been found necessary in order to produce the properties that we recognize as those of matter, and the minimum combination is identified as hydrogen. Successive additions of further units of motion conform to a definite pattern determined by probability considerations, and hydrogen is therefore followed by a series of specific combinations, which we identify as the chemical elements. The magnitudes of the three rotations of each of these elements can be represented by a unique set of three numbers.

Inasmuch as the combinations of motions *are* the atoms, and the speeds of rotation in the three dimensions are the only significant features of these atoms, it follows that the set of three numbers which represents the rotational speeds of an element determines the numerical magnitudes of all of the physical and chemical properties of that element, and those of the contributions which that element makes to the properties of chemical compounds. It is theoretically possible, therefore, to devise a system of mathematical expressions for each physical property, into which the numbers representing the rotational speeds of the element or elements can be inserted to obtain the values of the property in question.

Such expressions have already been developed for a number of physical properties, of which the volume relations have been the most extensively investigated. The basic

equation for calculation of the inter-atomic distance in the solid state was included in the original presentation of the Reciprocal System of theory in *The Structure of the Physical Universe*, published in 1959, along with an explanation of the most common of the modifications of the basic expression that are required by alternate structural patterns. Calculations on this basis for the simpler types of crystals were shown to agree with values reported from experiment, within the accuracy of the experimental results. Professor Meyer is now undertaking to extend these correlations to a wider variety of substances and to a higher degree of accuracy to obtain a definitive answer to the question as to the validity of the theory.

THE INTER-REGIONAL RATIO

At the 1984 ISUS conference in Salt Lake City a discussion of the “inter-regional ratio” concluded with an understanding that each of those concerned should write a statement of his ideas on the subject for publication in Reciprocity. What follows is Dewey B. Larson’s contribution.

The first point that should be noted in connection with this ratio is that it is a basic physical constant, like the gas constant, the gravitational constant, etc. Conventional physical theory has no explanation for any of these constants. It simply uses the, *measured* values, without attempting to explain where they come from, or what they mean, or even if they have any meaning.

If anyone has difficulty in following the theoretical derivation of the inter-regional ratio, I would suggest following this prevailing scientific practice for the present, and accepting this ratio as a measured value, leaving its theoretical status to be considered later, after more familiarity with the theory has been gained.

This ratio can, of course, be measured in the same way that the other fundamental constants are measured; that is, by applying one of the relations in which it participates. This is how I obtained it originally. I measured it and used it in my studies long before I formulated the Reciprocal System of theory and found a theoretical explanation for the measured value. In order to appreciate the significance of the ratio, it is necessary to have a reasonably good understanding of the basic features of scalar motion. The existence of this type of motion is not recognized by conventional science, but this is an obvious oversight, as scalar motion can be *observed*.

For instance, we find that the distant galaxies are all moving radially outward away from our own galaxy. Since we cannot justify assuming that our galaxy is the only stationary object in the universe, we have to conclude that we are likewise moving away from all of the other galaxies; that is, we are moving outward in all directions. A motion in all directions is a motion with *no* specific direction. Thus the motion of the galaxies is scalar.

From the postulates of the Reciprocal System of theory we find that the basic motions of the universe are scalar; simply relations between space magnitudes and time magnitudes. Once we have recognized that motion of this nature does actually exist, even though conventional science does not recognize it, the postulate that this kind of motion, the simplest form of motion, is the fundamental entity is entirely logical. Of course, fundamental postulates have to be justified by their consequences, but it helps to know that they are soundly based. In a three-dimensional universe of motion there are necessarily three dimensions of motion. That is what the adjective “three-dimensional” means. But only one dimension of *motion* can be represented in the three dimensions of *space* portrayed by the conventional reference system. Any motion in this reference system can be represented by a vector, and a combination of any number of such motions is a one-dimensional motion represented by the vector sum. In order to grasp the significance of the expression “three dimensions of motion,” the term “dimensions” has

to be interpreted in the mathematical sense; that is, the foregoing expression refers to a motion that requires three *independent* quantities for a complete definition. To distinguish these dimensions of motion from the dimensions of space, or of time, that can be represented in the conventional three-dimensional reference system, I am calling them *scalar dimensions*.

Any two scalar magnitudes of the same kind can be added algebraically. Thus two gallons of water plus three gallons of water amounts to five gallons of water. Scalar speeds are additive in a similar manner. A speed of x units added to a speed of y units arrives at a total speed of $x+y$ units. But if the second of these motions is taking place in two scalar dimensions with speeds of y and z respectively, the quantities y and z are independent, by definition. Since z is independent of y , it is also independent of $x+y$. It follows that when a motion is taking place in two or more scalar dimensions, only the speed in *one* of these dimensions can be added to another speed.

The same principle applies where there are other differences between scalar quantities; for example, that between motion in space and motion in time. Motion in the time region is an extension of ordinary vectorial motion into a second speed unit, a unit of motion in time, which, for reasons explained in my books, acts as a modifier of the spatial speed—that is, as motion in equivalent space, rather than a motion in actual time—as long as the net total motion is below the neutral level. There are no fractional units in the universe of motion, but the equivalent of a fractional unit of space (or time) can be produced by adding units of the inverse entity. A speed in the range between one unit of motion in space and one unit of motion in time (which is two units when measured from the spatial zero) can be obtained either by adding a fractional increment to a unit of motion in space or by adding a negative fractional increment to a unit of motion in time. Like scalar motion in different dimensions, scalar motion in time is independent of scalar motion in space, and these two different procedures therefore produce results that are independent.

The full range of the time region motion is two scalar units, from zero spatial speed to zero temporal speed. Inasmuch as the motion beyond the unit speed level is independent of that in the range below unity, it is not limited to the one dimension of motion represented in the reference system, but extends over all three dimensions. In each dimension, the speed may be either a modified spatial unit or a modified temporal unit, as indicated in the preceding paragraph. Consequently there are 2^3 , or 8, different permutations of the spatial and temporal motions. Of these, only one, the all-spatial combination SSS is commensurable with quantities in the reference system, and appears as a magnitude in that system. If one of the spatial motions is replaced by a temporal motion, as in SST, the resulting combination of scalar quantities is different from SSS, and independent of it, just as the dimensional combination $x+z$ is independent of the combination $x+y$. The same is true of the other possible permutations. The complete list is:

SSS	TSS
SST	TST
STS	TTS
STT	TTT

Here, then, is the size of the “container,” the capacity of the single space unit to contain compound units of motion in which the introduction of time components produces the equivalent of less than a unit of space. What we want to do next is to determine how many units of motion in the form of matter can exist in this 8-unit “container”. We have seen that the rotational motion of the atom around one of its three axes is one-dimensional. Each such rotation constitutes one unit of motion, and since the “container” has room for eight units it can accommodate eight of these rotations. So far we have been dealing with dimensions of space or time (equivalent space). Now we need to take into account the fact that the atomic rotation is taking place in three dimensions of *motion*, each of which can be resolved into three dimensions of space or time. In the two additional dimensions of motion the rotation of the atom is two-dimensional.

Each unit of this rotation occupies two of the scalar units of the “container”. Thus only four such rotations can be accommodated in each dimension of motion, the total number of different combinations of rotations for the motion as a whole is then $8 \times 4 \times 4 = 128$. What this means is that the space unit can contain 128 independent scalar motions, only one of which, the SSS combination, in the one dimension of motion represented in the reference system, appears as an observable quantity in that reference system. For the rotational motion alone, the ratio of total to observable motion is 128 to 1.

The fact that the rotational motion is rotation of a vibration introduces an additional factor, as the units of motion involved in the vibration add to the total motion content of the atom. As explained in my books, this addition amounts to $2/9$ of the rotational motion, making the complete inter-regional ratio $1 + 2/9$ of the rotational motion, making the complete inter-regional ratio $(1 + 2/9) 128$ to 1.

THE EFFECT OF GRAVITATION ON RADIATION

As I pointed out in the article on “[Reference Systems](#)” published in the Winter 1977-78 issue of *Reciprocity*, the representation of the physical universe in a three-dimensional spatial coordinate system is not fully in agreement with reality. This system cannot represent some of the properties that do exist, such as motion in time. whereas it portrays some properties of the universe that actually *do not exist*, such as the directions of scalar motions.

Gravitation, which is purely a scalar motion, simply reduces the scalar magnitude of the distance between the gravitating object A and any space-time location B. There is nothing in this phenomenon itself that gives it a direction in the context of the fixed reference system; that is, nature does not distinguish between a scalar motion of A relative to B, and a similar motion of B relative to A. It follows that when this motion is viewed in the context of the fixed reference system, where the motion must have a direction, this direction is imputed by chance. The motion as seen in the reference system will therefore be divided equally between motion of A toward B and motion of B toward A, even where, as in the case of gravitation action on radiation, all motion originates at the gravitating object A. This issue does not arise where A and B are both masses, as in that case there is a symmetrical distribution of the motion but it has a bearing on any case where the motion is asymmetrical.

The same effect can be seen in the induction of electric charges. The motion due to the charge, like the gravitational motion, is scalar, and even though it originates with object X, the motion as seen in the fixed reference system is divided equally between motion of X toward (or away from) Y and a similar motion of Y relative to X. The vibrational motion of X then becomes vibration of both X and Y.

ASTRONOMICAL X-RAY SOURCES

The discoveries of the past quarter of a century, including the x-ray phenomena, have taken astronomy into a totally new field, one in which it is evident, from the kind of difficulties that are being encountered, that some of the assumptions upon which conventional theory is based are not valid. Identification of the required modifications from within the system—that is, by reasoning from astronomical premises—encounters almost insuperable obstacles, and at many points progress toward understanding is at a standstill. Current literature is full of expressions such as “ever-deepening mystery,” “baffling problem,” “strange and inexplicable,” and so on.

By deriving the basic astronomical relationships from general physical premises, totally independent of astronomical observations or theories, the Reciprocal System of theory now provides what is needed: identification of the features of existing thought that must be replaced or modified. This new development is a *general* physical theory, based entirely on some far-reaching assumptions as to the nature of *space and time*, and originally derived from a critical study of the physical and chemical properties of matter. It applies to astronomical phenomena, as well as to the more general physical relations, because all astronomical objects are also physical objects, subject to the general physical laws.

An impressive feature of the results of the application of this Reciprocal System of theory—the RS theory as we will call it for convenience—is the way in which the simplification of the basic premises—deriving *all* conclusions from the *same* set of assumptions—accomplishes a drastic simplification of the processes that take place in the astronomical phenomena that are involved in the present discussion. Of course, a few cherished ideas of long standing must be sacrificed in order to enable accepting the premises of the new theory, but on careful consideration it will be found that there is no *real* sacrifice involved; that what has to be given up is only the *form* in which these ideas are currently expressed. Where there is real merit, the RS theory preserves the substance in a different form.

From the new theoretical development we find that the “mysterious” and “baffling” objects and events which the astronomers have recently discovered, and are now trying to understand, are ultra-high speed phenomena, in which the familiar physical relationships are inverted because the objects to which they apply are moving with speeds in excess of unity, the speed of light. The most important modification of conventional thought that is required by the Reciprocal System is therefore the elimination of the limitation on speed imposed by Einstein’s theory of motion at high velocities. The immediate reaction of most scientists is that this is unthinkable; that the validity of Einstein’s relationships has been demonstrated in countless experiments and applications, and that tinkering with them would lead to chaos in the high velocity field. But this is just another illustration of the way in which unsupported assertions acquire the standing of incontrovertible facts simply by virtue of long-continued repetition. The truth is that all of the achievements of Einstein’s theory—the agreement with experiment, the successful use of the theory in the design and operation of particle accelerators, etc.—are mathematical. What these results demonstrate is that the theory is mathematically correct.

But the limitation on speed does not come from the mathematics; it comes from Einstein's explanation of the mathematics.

Contrary to popular belief, this explanation, the *conceptual* aspect of Einstein's theory of motion at high velocities, has never been verified in any manner. Furthermore, it has the weakest possible kind of a foundation; it rests entirely on a pure *assumption*. The *fact* disclosed by experiment, and verified in practical application, is that when a presumably constant force of electromagnetic origin is applied to the acceleration of a presumably constant mass, the acceleration does not remain constant, as required by the definition of force, $F = ma$, but decreases at high speeds and approaches zero at the speed of light. This means that one of the presumably constant quantities is not a constant, but a variable. As most elementary physics textbooks point out, the mathematics are exactly the same whether the variable quantity is the mass or the force, and there is no physical evidence to indicate where the variation takes place. In the absence of such evidence, Einstein had to make an assumption, and he chose to build his theory—his *explanation* of the mathematical relations—on the basis of a variable mass. Development of the RS theory now indicates that he made the wrong choice, and that the variable quantity is actually the force; that is, instead of the mass approaching infinity as the speed approaches unity (the speed of light), the effective force approaches zero.

The significance of this difference in the interpretation of the mathematical relations is that if the *mass* were the variable quantity, as Einstein assumed, the limitation would apply to the speed. It would then be impossible to exceed the speed of light. But if the *force* is the variable quantity, in accordance with the conclusions of the RS theory, then the limitation is on the capabilities of the process; that is, the physical evidence then shows that it is impossible to produce a speed in excess of that of light by electromagnetic means. Such a limitation on the capability of one process does not preclude acceleration of a mass to a higher speed by some other process—by an explosion, for example. Replacement of Einstein's arbitrary selection from among the two possible interpretations of the mathematical pattern with the interpretation *derived theoretically* from the postulates of the Reciprocal System thus opens up the entire range of speeds beyond the speed of light without *altering any of the mathematics now being used in application to motion at speeds less than that of light*.

Recent advances in techniques and equipment for x-ray observation of astronomical objects have resulted in the accumulation of enough information to enable checking the general nature of the observational results against the theoretical picture derived from the development of the consequences of the postulates of the Reciprocal System of theory. X-rays can, of course, be produced in relatively small quantities by a number of different processes, but the RS theoretical development indicates that the source of the very strong radiation in this frequency range that is generated in astronomical objects is radioactivity from matter which has reverted to speeds below unity (the speed of light) after having remained at a higher speed long enough to attain isotopic stability at the ultrahigh speed.

This is the inverse of the process that theoretically gives rise to radiation at radio frequencies from the matter in objects such as quasars and pulsars that has just recently crossed the boundary in the other direction, from low speeds to ultrahigh speeds, and is in the process of attaining isotopic stability at the ultrahigh speeds. According to the

theoretical findings, as explained briefly in *Quasars and Pulsars*, and in more detail in a supplement to that book entitled *Quasars - Three Years Later*, the factors which govern atomic stability are, like all other properties related to the speed, inverted at the unit level. Under low speed conditions, the zone of isotopic stability in the normal galactic environment is above the basic level at which the atomic weight is twice the atomic number. In an earth-like environment, the deviation of the theoretical center of the zone of stability from this basic level is $z^2/156.45$ atomic weight units, where z is the atomic number.. At ultrahigh speeds, the direction of the mass increment is reversed, and in a corresponding environment, the zone of stability is centered at $z^2/156.45$ atomic weight units *below* the basic level.

This means that any matter which moves from low speed to ultrahigh speed, or vice versa, is outside the zone of stability at the new speed, and must undergo a radioactive process to move into the stable zone. For example, the center of the zone of stability for the element silver is 14.12 above the basic level, $2z = 94$, at low speeds, and 14.12 below this basic level at ultrahigh speeds. A radioactive change of isotopic weight from 108 to 80, or the reverse. At the low speeds of our ordinary experience, this radioactivity involves the emission of high frequency radiation: x-rays and gamma rays. At ultrahigh speeds, the emitted radiation is in an equivalent frequency range on the other side of the unit level, which puts it in the radio range.

The discrete astronomical sources of strong radiation of these two types are objects in which such radioactive transitions are taking place on a vast scale; where extremely large quantities of matter have been transferred from one speed range to the other in a relatively short period of time. The radio emitters are explosion products—quasars, radio galaxies, pulsars, etc.—composed wholly or in part of particles that have been accelerated from low speeds to speeds greater than unity by stellar or galactic explosions. Inasmuch as there are no *aggregates* of ultrahigh speed matter in the material (low speed) sector of the universe, other than these explosion products, the x-ray and gamma ray emission originates from those of the explosion products which return to the low speed range after spending a substantial period of time at the ultrahigh speeds.

In the chaotic conditions that exist in the turbulent products of the explosion of a star or galaxy, some of the atoms or particles that have acquired ultrahigh speeds drop back into the low speed range temporarily by reason of loss of energy in encounters with other particles, and emit high frequency radiation at the low speed. All of these explosion products are therefore x-ray sources as well as radio emitters, but the high frequency radiation is relatively minor in the quasars, and also in the pulsars (except under some special conditions that will be discussed later), because the speed of these objects is great enough to enable escape from the material sector, and the aggregate as a whole never returns. The high frequency emission from the low speed products of galactic explosions, the radio galaxies, is likewise relatively weak because only a small percentage of the mass of these objects is moving at ultrahigh speed, and while this matter was accelerated to the high speed suddenly, its reversion to the low speed range is spread out over a long period of time.

The strong x-ray emitters are explosion products of intermediate energy, those in which the entire aggregate initially acquires speeds that are greater than unity, but are not high

enough to permit escape from the material sector. These ultrahigh speed aggregates that remain in the low speed environment gradually lose energy to that environment, and ultimately drop back below the unit speed level. The speeds of the component particles follow the same course, and these aggregates therefore become x-ray emitters in the stage of their existence immediately following their return to the low speed range.

The intermediate-energy explosion products are of two kinds. The Type I supernova is not energetic enough to raise its high-speed explosion product, the white dwarf star, to the escape speed, and the entire white dwarf aggregate eventually returns to the low speed status after spending some time at the ultrahigh speed. The speeds of the products of the more powerful Type II supernovae are distributed throughout the entire range below the maximum value, and, although the fastest particles are able to escape in the form of pulsars, there are some portions of the explosion products that acquire speeds greater than unity, but below the escape limit. Like the white dwarfs, this material, which forms part of the objects that are observed as supernova remnants, reverts to the low speed status in time. Both kinds of products emit x-rays while the isotopic changes required by the inversion at the unit level are taking place. The relatively strong discrete x-ray sources are therefore mainly white dwarf stars and supernova remnants (or extragalactic aggregates containing these or similar objects).

In what we may call Stage 1, the immediate post-ejection period following the Type I supernova explosion in which the white dwarf star is formed, this star is expanding in time, which means that from a spatial standpoint it is contracting. In this stage, the constituent particles, newly raised to ultrahigh speeds, are emitting radiation at radio frequencies as they move toward isotopic stability at these speeds. Such a star is observable only as an otherwise unidentifiable source of radio emission. A great many such sources—"blank fields", as they are often called by the optical astronomers—have been located, and presumably some of these are Stage 1 dwarfs.

When the energy loss to the environment has been sufficient to terminate the contraction, a process of re-expansion begins, the first portion of which may be called Stage 2 of the white dwarf existence. In this stage an increasing number of the constituent particles of the star lose enough energy to drop below unit speed. The atoms of which these particles are composed then make the radioactive transition to the upper zone of stability, emitting x-rays and gamma rays in the process. In the early part of this stage, the radiation at optical frequencies is minimal, and the white dwarf is still not optically visible, manifesting itself only as a source of high-frequency radiation, and in its gravitational effect on its companion star. As the re-expansion proceeds, the white dwarf star continues accreting portions of the diffuse material ejected in the original supernova explosion, together with other matter from the environment, and gradually builds up an outer shell of low speed matter. This shell, increasing in thickness, absorbs more and more of the radiation from the interior, and ultimately the x-ray emission ceases. The star is then in Stage 3, the stage in which it is readily observable optically, and has the recognized white dwarf characteristics.

From theoretical considerations it has been deduced (see *The Structure of the Physical Universe*) that the equivalent of a pressure builds up in the interior of the white dwarf as the expansion toward gravitational equilibrium continues, and in Stage 4 this pressure

breaks through the overlying material periodically, exposing the radioactive material from the interior. During these outbursts (novae and related phenomena) x-ray and gamma ray emissions are again observable; that is, the high frequency radiation of Stage 2 is resumed on a *periodic* basis.

Summarizing, we find from theory that the relatively strong discrete sources of x-ray emission are (1) white dwarf stars, not optically visible, in the early part of Stage 2 of their existence, (2) novae and nova-like variable stars (Stage 4 white dwarfs), (3) local concentrations of matter, or diffuse clouds of matter, in remnants of supernovae, and (4) extra-galactic aggregates containing these or similar sources.

Here, then, is the general theoretical account of the principal sources of radiation in the x-ray range now being observed from astronomical sources, as derived from the basic postulates of the RS theory. As can be seen from the foregoing explanation, all of the information required to put this description together was already available in previous publications dealing with this system of theory. It had already been determined that the explosion products—quasars, pulsars, white dwarfs, etc.—theoretically undergo inverse radioactivity on crossing from the low speed to the ultrahigh speed range, and thereby produce radiation at radio frequencies. It had also been found, from theoretical considerations (see *Quasars and Pulsars*), that certain of these explosion products (quasars, for example) acquire sufficient speed to escape from the material (low speed) sector, whereas others (white dwarfs, for example) do not attain the escape speed, and eventually return to the normal, relatively low, speeds of that sector. All that was needed to complete the theoretical picture was a recognition of the rather obvious fact that the process previously deduced as the source of the radiation at radio frequencies from the products of stellar and galactic explosions also works in reverse to produce x-rays and gamma rays from those of the explosion products that return to the low speed range.

We thus have a theoretical definition of the origin and properties of the x-ray emitters that has not been constructed to fit the observations, in the manner in which most scientific theories are devised, but was already in existence *prior to the discovery* of the astronomical x-ray emission. The close agreement between this preexisting theory and the observational information thus obtained is therefore highly significant.

In undertaking a correlation between theory and observation, we will reserve the emission in the supernova remnants for later consideration, and will begin with the observations of the other strong galactic sources, which, the RS theory tells us, are early (Stage 2) white dwarfs, or nova-like late (Stage 4) stars of this class. According to the previously published theoretical account of the origin and nature of the white dwarfs, they are components of binary (or multiple) systems in which they are associated with stars that originate, coincidentally with the white dwarfs, as infrared stars, and pass through a super-giant or giant stage as they move toward gravitational equilibrium on the main sequence.

Inasmuch as the observable white dwarfs appear to be distributed rather uniformly among the stars in the disk of the galaxy (as the theory requires), it can be expected that both the continuous and the periodic x-ray emitters will share this uniform distribution, and the x-ray sources of this class should therefore be concentrated toward the galactic center and

the galactic equator in the same manner as the general run of disc stars. The observed distribution of the sources is in full agreement with this theoretical expectation.

Thus far, only about 20 percent of the x-ray emitters that have been identified as stars are definitely known to be members of binary systems, and the theoretical conclusion that they are *all* members of binary or multiple systems has been confirmed only to that extent, but there is no evidence to indicate that the remainder are *not* components of binaries. Indeed, it was suggested by R. Giacconi at a symposium reported in *Earth and Extraterrestrial Sciences*, Feb. 1973, that the evidence from observation warrants adopting “a working hypothesis that all galactic x-ray sources are either members of a binary system or supernova remnants.”

As stated in a review article in the *New Scientist*, the observations indicate that the x-rays “must originate from relatively small, compact objects.” The theoretical identification of these objects with the white dwarfs is in complete agreement with this and the previously stated conclusions from observation. The stars currently recognized as white dwarfs are “relatively small, compact objects”; they are members of binary systems in which they are associated with stars on or above the main sequence; and they are distributed in roughly the same manner as disk stars in general. These same statements are likewise applicable to the stars not currently included in the white dwarf class, but theoretically identified as Stage 4 white dwarfs, the novae and nova-like variables. The RS theory and observation are thus in complete harmony. But the predominant astronomical opinion rejects this straightforward interpretation, and invokes some products of the imagination to explain x-ray emission. As reported in *Science News*, Feb. 23, 1974:

The main candidates [as x-ray emitters] are black holes and neutron stars—though a few observers may hold out for white dwarfs.

In considering the conflict between the RS theory and current astronomical thought, it should be realized that there is no independent evidence of the existence of such things as neutron stars or black holes; they are purely hypothetical, and they are brought into the x-ray situation only because the accepted theory of the nature of the white dwarfs imposes limits on the range of sizes and densities of these objects: limits which are wholly theoretical and without factual support of any kind. From an *observational* standpoint, all of the ultrahigh density non-pulsating stars are alike. There is no physical evidence to indicate the existence of any division by sizes such as that which is required by current theory. The truth is that the inability of the conventional white dwarf theory to account for the full range of this group of observationally similar objects is a serious defect in the theory: one which, in most fields of science, would be enough to prevent its acceptance. But in this case, the *weakness* in the white dwarf theory is used as an argument *in favor* of the black hole theory, or at least, as conceded by the proponents of the theory, it is a “key link” in that argument.

When the hypothesis of black holes and neutron stars was first proposed as an explanation of x-ray emission, it was recognized in its true character as an extreme case of speculation. As seen by P. Murdin (*Nature*, Jan. 26, 1973), black holes are a “solution looking for a problem.” Only a “counsel of desperation,” he said, would suggest calling

upon such a hypothesis. Of course, even far-fetched speculations are scientifically legitimate, and sometimes serve a useful purpose, but unfortunately, there is a tendency to forget that they have no tangible basis. As they are repeated over and over again, they gradually acquire a standing merely by virtue of the repetition, and soon the observations which they were invented to fit begin to be accepted as evidence in their support. Anticipating this sort of development, G. R. Burbidge sounded this note of warning only two years ago (*Comments on Astrophysics and Space Physics*, July 1972):

Will it be firmly announced that black holes and/or neutron stars have been discovered . . . and shall we then build on this shaky foundation to explain even more about the universe?

Burbidge's apprehensions have been fully justified. The *observational* status of the black hole hypothesis is no firmer now than it was when his comments were made. It has been *enlarged* by the addition of subsidiary hypotheses, but aside from the things that have been deliberately built into the theory by means of these additional hypotheses (for example, a reason why the emitters are members of binary systems), none of the new items of information that have been derived from observation, such as those discussed in these pages, can be explained by means of the black hole theory. Since every additional unexplained or contradictory item weakens the theory, its status has deteriorated to that extent. Notwithstanding the reluctance of those who are working in this area, to concede the point, black holes and neutron stars are still pure speculations, just as they were when first proposed. "Black holes," say Fabian and Pringle (*New Scientist*, Feb. 7, 1974), "are still in the realm of science fiction."

This black hole hypothesis—"Of all the conceptions of the human mind . . . perhaps the most fantastic," says K. S. Thorne, *Scientific American*, Dec. 1974 (not, as one might assume from his words, a caustic critic of the black hole theory, but one of its enthusiastic protagonists)—is another example of the results of the general unwillingness to reevaluate existing ideas or theories when new information becomes available. When the existence of matter at ultrahigh densities was first brought to light by the discovery of the white dwarf stars, it was found possible to devise a theory which appeared plausible in the light of the facts that were known at that time. But later, when the *same* phenomenon—ultra-high density matter—was encountered in the form of quasars, where the existing white dwarf theory was obviously inapplicable, instead of taking the hint and reexamining the white dwarf situation, the theorists have devoted their efforts (so far unsuccessfully) to finding some different explanation to fit the quasars.

Then, when the same ultra-high density showed up in the pulsars, still another explanation was required, and this time the neutron star hypothesis was invented. Now we again meet the same ultra-high density in the constituents of the x-ray emitters, and since none of the previous explanations fits this case, we must again have a new theory. Here the resourceful theorists bring out the black hole. So in order to explain the different astronomical manifestations of one physical phenomenon—ultra-high density matter—we have an ever-growing multitude of separate theories, one for the white dwarf, one for the pulsars, at least two for the x-ray emitters, several for the dense cores of certain types of galaxies, and no one knows how many for the quasars.

The application of the RS theory to the problem merely accomplishes something that was long overdue in any event: a reevaluation and reconstruction of the entire theoretical structure—particularly the white dwarf theory—in the light of the vastly greater amount of information now available. This theoretical investigation shows that the ultra-high density results, in all cases, from the same cause, and all of the ultra-high density stars, regardless of whether we observe them as white dwarfs, pulsars, x-ray emitters, or unidentified sources of radio emission, are identically the same kind of objects, differing only in their speeds and in the current stage of their radioactivity. The existing multiplicity of theories is not only confusing, but definitely misleading, and wholly unnecessary.

The next significant item of observational evidence that should be noted is that the “normal stars in x-ray binary systems are O and H super-giants” (*Sky and Telescope*, Nov. 1974). Theoretically, the companions of the white dwarfs in the *largest* binary systems should be super-giants, when these companions first reach the stage where they are optically visible. Since these large systems are the strongest emitters, they are the easiest to identify, and the fact that the first few systems to be located have super-giant components is therefore in accord with the theoretical expectation. However, the range of white dwarf companions in the optically observed binary systems extends all the way to the main sequence. It can be expected, on the same basis, that as observational techniques and facilities are improved, some infrared stars (earlier than super-giants), some giants (smaller than super-giants), and some main sequence stars (later than super-giants), will also be found associated with x-ray emitting white dwarfs. Indeed, the observations already reported include an infrared component of Cygnus X-3.

According to the RS theory, this diversity in the type of the companions of the white dwarfs is a result of differences in the relative rates of evolution of the two components. The binary systems containing observable white dwarfs (Stage 3, no x-ray emission) evolve toward the main sequence, the giant star contracting and the white dwarf expanding, both moving toward gravitational equilibrium. As mentioned earlier, Stage 3, the latter portion of the expansion period, is characterized by periodic outbursts of an explosive nature, and the normal white dwarf is therefore followed by a succession of novae and nova-like variables. The general nature of these “cataclysmic variables” (a term used to apply to “novae, recurrent novae, dwarf novae, and nova-like variables” in an article in *Sky and Telescope*, Nov. 1973) is clearly in agreement with the conclusions of the RS theory. As the foregoing article says, such a star “is a close binary system in which the primary component is a white dwarf, The secondary is a normal star”.

The astronomical community is currently unwilling to accept the theoretical conclusion that the cataclysmic variables are *successors* of the normal white dwarf stars, because the observations do not define the direction of the evolution of these systems, and conventional thinking assumes that the normal white dwarf is in the last evolutionary stage of optically visible stars, the last stage before they descend into the hypothetical realm of black dwarfs, neutron stars, and black holes. But the conclusions of the RS theory with respect to the direction of evolution of the white dwarfs are now given powerful support by the x-ray observations, which reveal that there are, in fact, “x-ray novae”, as asserted by the theory. Elliott and Liller (*Astrophysical Journal*, July 15,

1972) report that there is “some compelling observational evidence that relates the nova phenomenon, ...With at least some galactic x-ray sources”. These authors concede that the x-ray emission comes only from *some* of the novae, or only at *some* times. “Certainly not all old novae are galactic x-ray sources”, they say. The observations thus agree with the theoretical finding that only the interior material of the Stage 4 star is emitting high frequency radiation, and that, as a consequence, the x-ray are observable only when the explosive outbursts bring the interior material to the surface.

As noted earlier, there are some special conditions under which it is theoretically possible to have x-ray emission from pulsars, radiation which, like the radio emission from these objects is received in regular pulses. It was pointed out in *Quasars and Pulsars* that the two components of a binary system do not necessarily undergo supernova explosions at the same time, even though both are of the same age, and it is therefore quite possible that a second such explosion may take place in the remnants of the first. In such a case, relatively rapid accretion of matter by the second pulsar can be expected. This accreted low-speed matter will interact with the adjacent portions of the pulsar, and will reduce the speeds of some of its constituent particles below the unit level, causing the emission of x-ray. If the accretion proceeds far enough while the pulsar is still within observable range, the optical radiation from the accreted matter will also be visible, Inasmuch as all of the three types of radiation, radio, x-ray, and optical, originate in the rapidly moving pulsar, the pulsation rates will be the same for all.

The observed characteristics of the pulsar 0531+21 in the Crab Nebula are in full agreement with this theoretical pattern. Optical, x-ray, and radio emissions have been observed, and all have the same pulsation period. This x-ray emission, produced in the outer regions of the pulsar, is stronger than the radio emission from the interior, as would be expected. This pulsar is located approximately in the center of a mass of diffuse material, the characteristics of which are such as to lead to the conclusion that it is made up of two dissimilar components,' suggesting that it originated in two separate events. Furthermore, a second pulsar, 0525+21, has been located in a position which is generally believed to indicate association with this nebula.

The recently reported discovery of a pulsar, 1913+16, which appears to be a member of a binary system and *not* an x-ray emitter, is of interest in this same connection, inasmuch as these characteristics suggest that this is a case where the pulsar has originated from the *first* explosion in a binary system, rather than the second. Like the Crab Nebula pulsar, 1913+16 is the only member of its class thus far discovered, Indeed, it was stated in *Nature* only a few months before this discovery that “no known pulsar is a member of a binary system”, The scarcity of such objects indicates either that our galaxy is not old enough to have many Type II supernova explosions of binary systems (second generation stars), or else that the interval between the two explosions is ordinarily considerably greater than in the two known cases,

Another situation in which x-ray emission from a pulsar could theoretically occur is that which would exist if, for any reason (perhaps a continuation of heavy accretion), the pulsar loses so much energy that it drops below the escape speed, In that event, it will follow the same course as the white dwarf, eventually returning to the low speed range, and emitting high frequency radiation in the process. Ultimately, it will be

indistinguishable from the ordinary white dwarf. Unlike that star, however, the retarded pulsar will be returning from an unobservable condition at a (temporal) distance outside the observable range, and in reentering the observable region it will pass through the same pulsation zone that it crossed on the way out, while in this zone, the x-ray radiation will be pulsed in essentially the same manner, and within the same range of pulsation periods, as the radio emission from the outgoing pulsars.

The x-ray radiation from accelerating pulsars should always be accompanied by strong radio emission, and pulsed x-rays without any more than a weak radio accompaniment can theoretically be regarded as originating in decelerating pulsars. Another distinguishing characteristic is the direction of change of the period. The periods of the accelerating pulsars are, of course, increasing. Those of the decelerating objects are decreasing, but the rate of change is relatively slow, and within the current accuracy of measurement, the period may appear to be constant. Aside from that of the Crab Nebula pulsar, 0531+21, no increasing x-ray pulsation periods have been found. The other observed sources of pulsed x-rays therefore appear to be decelerating pulsars. In the case of one of them, Cen X-3, it has been specifically reported that the pulse rate is *not* slowing down.

The near absence of observable x-ray pulsars in the accelerating stage tends to support the theoretical conclusion that the observable portion of this stage, the period of time during which a pulsar is observable after the supernova explosion, is very short. The theoretical basis of this conclusion appears to be firm, inasmuch as the age of the oldest pulsar thus far located, calculated from its pulsation period as 9100 years, is consistent with the maximum observable life, calculated from gravitational fundamentals as 13,000 years (where the gravitational restraint is exerted by one solar mass). However, the only definite observational evidence that was available to support such a short life at the time the foregoing values were published in *Quasars and Pulsars* was the observed ratio of pulsar life exceeded the calculated figure by any substantial amount. In the meantime, further observational support has accumulated, including this confirmation of the theoretical deduction as to the rarity of observable x-ray pulsars.

Additional confirmation of a more direct nature has come from the supernova remnants. These remnants have been more carefully examined for evidence of association with the pulsars, and it is now conceded that this evidence is conclusive in only two cases—the Crab Nebula (900 years) and the Vela remnant (currently estimated at 11,000 years, calculated at 1500 years). Eric M. Jones (*Astrophysical Journal*, July 1, 1974) summarizes the situation as follows:

Although the numbers of identified supernova remnants and known pulsars both approach 100, only two well-established pulsar-SNR pairs are known.

The fact that associations of greater ages are not *observed* is strong support for the theoretical conclusion that they are not *observable* for longer periods of time. The possibility that the pulsar and the remnants may have moved apart since the explosions, so that association is no longer evident, has been investigated, but it is difficult to obtain any specific evidence, that such a separation has actually occurred. On the other hand, there is evidence that separation of the two objects does not *always* occur, since the

pulsars in the observed association are centrally located, as most, if not *all* of them theoretically should be. This available evidence is conclusive, as the conclusion with respect to a limiting age is conclusive, as the calculated figure is essentially the same regardless of whether *all* of the pulsars remain within the remnants, or only *some* of them remain. In either case, if the very low age limit did not exist, pulsars should be found associated with at least *some* of the remnants of greater age.

Current views as to the pulsar life, which differ radically from the conclusions of the RS theory, are based on the *assumption* that the increase in the period of pulsation is linear with respect to time. On this basis, ages in the range from 103 to 108 years are obtained by dividing the period by the rate of increase, expressed on an annual basis. But the finding of the RS theory that the age is proportional to the square root of the pulsation period means that, instead of being a simple quotient as assumed, the age is inversely proportional to the effective rate of change of the period. It is necessary to specify that this relationship applies to the effective rate of change because the theory indicates that the measured quantity, the continuous change, is the third power of the *effective* rate, the difference being taken up in time adjustments (sudden changes in the period similar to the observed phenomena known as “glitches”) resulting from the pulsar motion in time. Theoretically, therefore, the age of the pulsar is inversely proportional to the $1/3$ power of the measured rate of change of the period.

Application of this relation to the two youngest pulsars for which complete data are available arrive at an age ratio of 1.5. On the basis of 900 years for the Crab pulsar, this gives us 1350 years as the age of 0833-45. The age of this pulsar calculated directly from the period is 1480 years. The agreement is within ten percent, which is probably as close as we can expect at the present stage of observational and theoretical development. Because of the many factors that affect the “fine structure” of the pulsation periods, and the greater proportionate effect of these factors at the lower rates of change, the individual deviations of the ages similarly calculated for the pulsars of longer periods exceed ten percent in many cases, but the average deviation is even less, except at the very low rates of change. For example, a compilation of pulsar data by Y. Terzian (Aug. 1972) includes 20 pulsars with periods lengthening more than .100 n sec per day, and the *average* deviation between the ages of these 20 pulsars calculated from the rate of change of the period and the ages calculated directly from the period is only four percent. This is clearly a confirmation of the theoretical deductions.

The finding of G. R. Huguenin, et al. (*Astrophysical Journal*, Oct. 1, 1971) that the evolutionary properties of the pulsars—from simple to complex—are related to the period is further evidence in support of the theoretical conclusion that the period is a function of the age. These observers classify the pulsars into three groups, those in which the pulse shape is simple, those in which it is complex, and an intermediate group. All of the pulsars of the simple type have periods less than one second; all of the complex type have periods less than one second. Complex pulsation periods will theoretically develop as the pulsar overcomes the gravitational retardation and gets up to full speed, for the same reasons that apply to the development of complex radio structure in the quasars. The double-peaked pulse (double temporal structure) that is typical of pulsars with

periods greater than one second is analogous to the double spatial structure of the quasar radio emission (See *Quasar - Three Years Later*).

It will be appropriate to close the discussion of the compact x-ray sources by checking the theoretical findings outlined in the foregoing pages against G. R. Burbidge's itemization of "What we need to explain" (*Comments on Astrophysics and Space Physics*, July 1972). His list is as follows:

1. The great power of the sources.
2. Rapid and complex variability.
3. Binary character.
4. Rarity of powerful x-ray sources compared with the number of close binaries.
5. Non-thermal radio emission from two x-ray sources and non x-ray binaries.

All of those features are explained by the RS theory. The following comments may be made with respect to the individual items:

1. 1. Strong radioactive emission from masses of stellar magnitude is obviously sufficient to explain both the x-ray and the radio power.
2. 2. Emission from constantly changing groups of isotopes with half-lives all the way from seconds to years accounts for both the rapidity and the complexity of the variation. Where a single event (a "burst") can be identified, the decay follows the normal exponential pattern of radioactivity, a pattern which, as noted in the *New Scientist*, Apr. 18 1974, is "incompatible with the usual models".
3. 3. According to the theory, all of the compact galactic x-ray sources are white dwarfs or pulsars. These are the high speed products of Type I and Type II supernova explosions, respectively. The low speed products of these explosions ultimately consolidate into stars, and form binary systems with the white dwarfs and those of the pulsars that return to the low speed region. The theory thus requires all of the compact x-ray emitters to be members of binary systems.
4. 4. This is simply a matter of the comparative amount of time spent in the respective stages. The x-ray emitting period in the life of a white dwarf is very short.
5. 5. All x-ray emitters are radio emitters earlier, and produce x-rays in a later stage when they lose the ultra-high speed that was the cause of the radio emission. But the speeds of the individual atoms in the aggregates are distributed over a wide range, and there is some x-ray emission from the radio aggregates, and some radio emission from the x-ray aggregates.

When the speed of the aggregate is near the boundary line, the amount of the deviant radiation may be substantial. As noted in the discussion of the Crab pulsar, it is also possible for the outer portion of a compact aggregate to revert to low speed and begin

emitting x-rays, while the material in the interior is still radiating strongly at radio frequencies.

The RS theory meets all of Burbidge's specifications fully and easily, not by a series of hoc constructions tailored to fit the observations, but by a purely deductive, and wholly inflexible, process of development of the consequences of the Reciprocal System of theory is based. If *space and time* do, in fact, have the postulated properties, then x-ray emission *must* take place from certain specific types of astronomical objects (the existence of which is required by the theory) in a particular stage of their existence, and the emission *must* have the particular characteristics that have been described.

Turning now to a consideration of the emission from the supernova remnants, we find that very little in the way of detailed information is available as yet. One point of interest is that much of the high frequency radiation from these objects appears to be coming from localized areas within the remnants, such as an x-ray "hot spot" that has been reported in the center of Cygnus Loop.

The remnants provide an opportunity for observing the older x-ray emissions, which differ significantly from those of more recent origin. As is evident on examination of the properties of the common isotopes of the elements, the more distant the isotope is from the center of the zone of stability, the more energetic the radiation, and the shorter the half-life, on the average. Consequently, the original "hard", or energetic, x-rays from matter dropping back into the low speed range becomes softer as time goes on and the short-lived isotopes are eliminated. As indicated in the discussion in the preceding pages, the x-ray emission from the compact sources is cut off at a rather early stage by accretion of an outer shell of low speed matter, and according to the theory, the remnants are the only sources that are old enough to have eliminated most of the hard component. This theoretical conclusion is in full agreement with the observations. As reported by R. Giacconi (*Physics Today*, May 1973), there is no evidence of the existence of any source, aside from the older remnants, that emits only x-rays below 1 keV energy.

Giacconi also notes that the compact x-ray sources are either "exceedingly rare or represent short-lived x-ray emitting phases in stellar evolution". The theoretical identification of the soft x-rays with age, and the evidence from the remnants that ages of 25,000 to 50,000 years are sufficient to reduce the emission to the soft status, show that the second alternative is the correct one. The production of x-rays in the interiors of the white dwarfs continues until all of the ultra-high speed matter has reverted to low speeds—a process that requires a billion years or more—but this radiation escapes from the surface of such a star only under special circumstances of short duration.

The correlation of x-ray energy with age enables differentiating between the emission from remnants and that originating in compact sources associated with, or contiguous to, the remnants. For example, where a pulsar originates in a remnant, or returns to ray emission will consist of two dissimilar components. That from the pulsar, initiated relatively recently in either of the two situations mentioned, will be more energetic (harder) than the emission from the remnants, which dates back almost to the original supernova explosion. The two components can therefore be distinguished on this basis. Such an identification has already been made in the case of Hercules X-1, and the ability

to differentiate between the emissions from different sources will no doubt be helpful in overcoming some of the difficulty that has been experienced in determining the nature of other x-ray sources.

It has been reported that there is no remnant at the Hercules location, but, of course, this merely means that no optical evidence of a remnant has been detected. As noted in *Quasars and Pulsars*, a large proportion of the total mass of the star that explodes in a Type II supernova goes into the high speed product, and since this material is not optically visible, there are many relatively young remnants that cannot be identified optically until some later date when they have lost enough energy to bring a substantial part of the ultra-high speed matter back into the low speed (visible) range. The existence of so much invisible matter in the remnants, and its slow reversion to the lower speeds, with the accompanying radioactivity, also explains the variability, the long duration, radioactivity, and the large total amount of the energy release in the Type II remnants, an amount which, as some observers have commented, appears, in many cases, to be inconsistent with the visible state of the remnants.

Somewhat similar “remnants”, as well as compact sources of radiation, will also be formed as a result of explosive events in the galaxies, not only the violent explosions that eject the quasars, but also the emission of jets of material from galaxies such as M. 87, and the more widely dispersed ejections from the Seyfert, and other intermediate type, galaxies. The galactic explosions differ from the supernovae not only in size, but also in some other respects, particularly in that they hurl their products outward, giving them a spatial motion, whereas the high speed product of a supernova—a white dwarf or a pulsar—remains at the spatial site of the explosion unless that explosion is, for some reason, asymmetrical. Also the products of the galactic explosions are subject to powerful gravitational forces, whereas the gravitational retardation of the supernova products is relatively minor. Because of these differences in the controlling factors, the extra-galactic x-ray source do not follow a systematic pattern, in the manner of their galactic counterparts. Their distribution is essentially random, except that emission from diffuse matter (extended sources) is still concentrated enough to be observable only while this matter is still in the general vicinity of the galaxy or galaxies from which it was expelled.

Unquestionably, the most important fact thus far disclosed by x-ray observations of the supernova remnants is simply the *existence* of the strong emission from these sources. There is no obvious or *a priori* reason why such remnants should necessarily emit x-rays, or, for that matter, why *any* astronomical object should emit x-rays. “The discovery of cosmic x-rays was totally unexpected”, says R. J. Gould (*American Journal of Physics*, My 1967). Current astronomical thought is still groping for an explanation of the conditions under which the emission takes place, and the mechanism by which the x-rays are produced. As expressed by G. R. Burbidge in the reference previously cited. “We don’t really know... how the basic radiation mechanisms operate and are maintained”. The symposium report mentioned earlier includes this statement:

Most of the known, realistic mechanisms for the generation of x-rays lead to somewhat complicated theoretical statements, and the number of adjustable parameters is often too great for comfort.

The special significance of the emission from the supernova remnants is that, unless we make the rather farfetched assumption that there are *two* processes by which astronomical objects produce x-rays in immense, totally unprecedented, quantities, the emission mechanism must be one that is applicable to *both* of the observed types of galactic sources: highly condensed stars and supernova remnants. This not only rules out the currently popular speculations that invoke the hypothetical properties of hypothetical entities such as neutron stars and black holes, but also imposes some severe constraints on the kind of a process that can be given serious consideration.

Furthermore, when the observed emission of x-rays from the remnants of the supernovae is considered in conjunction with the results of the observations that have sought, but failed to detect, high frequency radiation in significant amounts from the supernovae, a still more rigid requirement is imposed on astronomical x-ray theory. The fact that emission occurs both from concentrations of matter (hot spots) and from diffuse clouds (extended sources) in the remnants means that the emission must result from the condition of the matter itself, not from the nature of the aggregate. But the absence of high frequency radiation during the observable stage of the supernova explosion, when the particle energies are at a maximum, shows that temperature alone is not the answer, and that thermal processes are not, in themselves, adequate to account for the strong x-ray emission.

In the remnants (and in the other sources as well, if those sources are products of supernovae, as generally believed) the emission comes from matter which has been losing energy—for 50,000 years or more in some cases—and is now at an energy level far below the peak reached in the explosion. The observations thus require the existence of a process in which matter that loses a portion of its energy after having reached explosive energy levels undergoes some change that involves emission of x-rays. Conventional theory knows of no such process, but according to the RS theory, this is just exactly what takes place in the explosion products of intermediate energy.

When it is realized that a satisfactory theory not only has to meet these rigid requirements of a general nature, but also has to provide an explanation of the existence of “x-ray novae”, a reason why the compact x-ray sources occur (so far as we can tell) only in binary systems, why some emissions are pulsed and some are not, and other such details, it is clear that this presents a formidable challenge to any theory of the phenomena that is proposed. It should not be surprising, therefore, that conventional astronomical theory is unable to cope with the situation. The discoveries of the past quarter of a century, including the x-ray phenomena, have taken astronomy into a totally new field, one in which it is evident, from the kind of difficulties that are being encountered, that some of the assumptions upon which conventional theory is based are not valid. Identification of the required modifications from within the system—that is, by reasoning from astronomical premises—encounters almost insuperable obstacles, and at many points progress toward understanding is at a standstill. Current literature is full of expressions such as “ever-deepening ” “problem” “strange and inexplicable”, and so on mystery , “baffling problem”, “strange and inexplicable”, and so on.

By deriving the basic astronomical relationships from general physical premises, totally independent of astronomical observations or theories, the Reciprocal System of theory

now provides what is needed: identification of the features of existing thought that must be replaced or modified. This new development is a *general* physical theory, based entirely on some far-reaching assumptions as to the nature of *space and time*, and originally derived from a critical study of the physical and chemical properties of matter. It applies to astronomical phenomena, as well as to the more general physical relations, because all astronomical objects are also physical objects, subject to the general physical laws.

An impressive feature of the results of the application of this RS theory (one that is to be expected, but is no less impressive for that reason) is the way in which the simplification of the basic premises—deriving *all* conclusions from the same set of assumptions—accomplishes a drastic simplification of the processes that take place in the astronomical phenomena that are involved in the present discussion. In the context of the RS theory, *all* of the compact, high density astronomical objects—quasars, pulsars, observable white dwarfs, x-ray sources, etc.—originate in the *same* manner (as the result of explosions). The extremely high density of *all* of these objects is due to the *same* cause (ultra-high speeds imparted by the explosions). The strong radiation—radio and x-ray—observed from these sources in certain periods of their existence results in *all* cases from the *same* process (isotopic adjustment necessitated when matter goes from low speed to ultra-high speed, or vice versa). As shown in the description of the theoretical development in this and previous publications, the differences between the various explosion products, and their behavior, can be accounted for, in full detail, by the conditions under which they are produced, and under which they currently exist: the character and power of the explosions, the nature of the environment, etc.

Of course, a few cherished ideas of long standing must be sacrificed in order to enable accepting the premises of the new theory, but on careful consideration it will be found that there is no *real* sacrifice involved; that what has to be given up is only the *form* in which these ideas are currently expressed. Where there is real merit, the RS theory preserves the substance in a different form.

From the new theoretical development we find that the “mysterious” and “baffling” objects and events which the astronomers have recently discovered, and are now trying to understand, are ultra-high speed phenomena, in which the familiar physical relationships are inverted because the objects to which they apply are moving with speeds in excess of unity, the speed of light. The most important modification of conventional thought that is required by the Reciprocal System is therefore the elimination of the limitation on speed imposed by Einstein’s theory of motion at high velocities. The immediate reaction of most scientists is that this is unthinkable; that the validity of Einstein’s relationships has been demonstrated in countless experiments and applications, and that tinkering with them would lead to chaos in the high velocity field. But this is just another illustration of the way in which unsupported assertions acquire the standing of incontrovertible facts simply by virtue of long-continued repetition. The truth is that all of the achievements of Einstein’s theory—the agreement with experiment, the successful use of the theory in the design and operation of particle accelerators, etc.—are *mathematical*. What these results demonstrate is that the theory is mathematically correct, but the limitation on speed does

not come from the mathematics; it comes from Einstein's *explanation* of the mathematics.

Contrary to popular belief, this explanation, the *conceptual* aspect of Einstein's theory of motion at high velocities, has never been verified in any manner. Furthermore, it has the weakest possible kind of a foundation; it rests entirely on a pure *assumption*. The *fact* disclosed by experiment, and verified in practical application, is that when a presumably constant force of electromagnetic origin is applied to the acceleration of a presumably constant mass, the acceleration does not remain constant, as required by the definition of force, $F=ma$, but decreases at high speeds and approaches zero at the speed of light. This means that one of the presumably constant quantities is not a constant, but a variable. As most elementary physics textbooks point out, the mathematics are exactly the same whether the variable quantity is the mass or the force, and there is no physical evidence to indicate where the variation takes place. In the absence of such evidence, Einstein had to make an assumption, and he chose to build his theory—his *explanation* of the mathematical relations—on the basis of a variable mass. Development of the RS theory now indicates that he made the wrong choice, and that the variable quantity is actually the force; that is, instead of the mass approaching infinity as the speed approaches unity (the speed of light), the effective force approaches zero.

The significance of this difference in the interpretation of the mathematical relations is that if the *mass* were the variable quantity, as Einstein assumed, the limitation would apply to the speed. It would then be impossible to exceed the speed of light. But if the *force* is the variable quantity, in accordance with the conclusions of the RS theory, then the limitation is on the capabilities of the process; that is, the physical evidence then shows that it is impossible to produce a speed in excess of that of light by electromagnetic means. Such a limitation on the capability of one process does not preclude acceleration of a mass to a higher speed by some other process—by an explosion, for example. Replacement of Einstein's arbitrary selection from among the two possible interpretations of the mathematical pattern with the interpretation *derived theoretically* from the postulates of the Reciprocal System thus opens up the entire range of speeds beyond the speed of light *without altering any of the mathematics now being used in application to motion at speeds less than that of light*.

This is a good example of the way in which the Reciprocal System of theory accomplishes the objective of eliminating the errors and misconceptions of conventional theory without disturbing its valid and useful features. Of course, this is just what a correct general physical theory must do. The essential elements of existing theories are empirical. These theories agree with observations, and particularly with the observed mathematical relations, because they were designed specifically for this purpose. A valid general theory must also agree with the observations and measurements, and it must therefore arrive at these same results. But if a theory is to be anything more than a description of the observations, it must provide an interpretation of the observed facts, and this is where so many theories go wrong, as there is usually very little of a solid nature on which the theorist can rely for guidance. As expressed by Sir James Jeans:

The history of theoretical physics is a record of the clothing of mathematical formulae which were right, or very nearly right, with physical interpretations which were often very badly wrong.

There is a tendency on the part of each new generation of scientists to assume that “things are different now”, and that the surmises and conjectures involved in the current interpretations of observations and measurements are somehow free from errors of the kind that have been so prevalent in the past, but it should not require any great perspicacity to enable realizing that as long as any kind of guesswork enters into the construction of theories, mistakes will be made. The question that now confronts us is not whether there are errors in current astronomical thought, but where the errors are. This is the question that the Reciprocal System of theory is now ready to answer.

D. B. Larson
December 1974

THE CRAB NEBULA PULSAR

Letter to the Editor of Reciprocity:

Those of your readers who noted the theoretical basis of my article on [Astronomical X-ray Sources](#), which appeared in your March 1975 issue, should be interested in the additional information concerning the emission from the Crab Nebula pulsar (NP 0532) that was obtained in recent observations that took advantage of occultation of the pulsar by the moon. As reported in the Jan. 10 issue of Science News, the observations show that all of the x-ray emission is coming from the nebula surrounding the pulsar and none from the surface of the pulsar itself. These results came as a distinct surprise to the astronomers and indicate the need for a revision of current ideas as to the physical nature of the pulsars.

On the other hand, the new information is in full agreement with the explanation of the emission that I gave in my article. According to my findings, the x-rays come from matter which has dropped back to speeds below unity (the speed of light) after having spent some time at higher speeds. As I pointed out in the article, in those cases where there is considerable diffuse low-speed material in the vicinity of the pulsar, as there is in the Crab Nebula, this material “will interact with the adjacent portions of the pulsar, and will reduce the speeds of some of its constituent particles below the unit level, causing the emission of , x-rays.” These low speed particles will, of course, lag behind the matter of the pulsar itself and will form part of the nebula, or halo, around the pulsar, the region from which the new observations show that the x-rays are emitted.

— D. B. Larson (Reciprocity VI.1, March 1976)

QUASARS – THREE YEARS LATER

Three years have now passed since publication of the book *Quasars and Pulsars* in which a detailed explanation of the existence and properties of the quasars was derived by pure reasoning from the properties of space and time as postulated in what is known as the Reciprocal System of physical theory. In the meantime further observations of these objects have been made, hypotheses and conjectures of all sorts and descriptions have been proposed, tested and discarded, and the astronomers and others concerned have had additional time to assess the significance of the various bits of knowledge that have been accumulated, and to weigh the attempts at explanation of the phenomena more carefully. It would appear, therefore, that it is now in order to take a look at the question as to how well the theory outlined in *Quasars and Pulsars* has been able to cope with the new information developed during the three year period, and where this theory now stands in comparison with the more conventional views of the subject matter.

It was generally conceded three years ago that in the light of orthodox physical and astronomical theory as it then stood the nature of the quasars could legitimately be characterized as a mystery. The present situation is summed up by Cyril Hazard and Simon Mitton in an article in the *New Scientist* of Nov. 29, 1973 as follows:

After a decade of astonishing progress for astronomy... quasars still remain the profoundest mystery in the heavens.

Nor is there any indication, according to these authors, that the dawn is breaking. On the contrary, their article is entitled “The Deepening Quasar Mystery.”

The explanation presented in *Quasars and Pulsars* requires a change in the fundamental concepts underlying physical theory, and for that reason most astronomers have thus far been reluctant to accept it, but the continuing inability of conventional theory to keep pace with the new observational discoveries, or even to make any appreciable progress toward resolution of the most basic issues that are involved (“a decade of observation”, says *Science News*, “has led to no agreement as to what they (the quasars) are or where they are”) suggests that the time has now arrived when more serious consideration should be given to a theory that accomplishes what conventional theory has been unable to do. When viewed in the light of the new theory there is no mystery about the quasar phenomena. *Quasars and Pulsars* provided an account of the origin, nature, and characteristics of the quasars that was in full accord with all of the information that was available at the time of publication. The objective of the present discussion is to show that the additional knowledge in this area that has been gained in the intervening three year period is equally consistent with the new theory, and puts it in a still stronger position vis-à-vis those portions of current thought with which it is in conflict.

The basis of the new theoretical development is an entirely new concept of the nature of the physical universe. Current physical thinking assumes a universe of matter: one in which the fundamental entities are elementary units of matter existing in a framework provided by space and time. But we now know, definitely and positively, that this assumption is wrong, because we have found means whereby matter can be converted into non-matter and vice versa. Obviously, this shows that matter is not basic. There

clearly must be some common denominator underlying both matter and non-matter. Most of the present-day “laws” and “theories” of physical science are based on empirical rather than purely theoretical foundations, and these are not affected by errors in fundamental concepts, but to the extent that current physical thought reasons from theoretical premises it is resting on a false foundation. This is a weakness that is certainly serious enough to account for the inability of present-day theories to meet the demands that are now being placed upon them, particularly in the astronomical field.

The premise on which the new theoretical development is based is that the common denominator, the fundamental entity from which all physical existences and phenomena are derived, is *motion*. The concept of a universe of motion is not, in itself, a new idea, but this work, for the first time, has postulated a universe composed *entirely* of motion—one in which even space and time have no significance other than their status as aspects of motion. When the properties of space and time are specifically defined on this basis they constitute a set of assumptions from which a potentially complete theoretical universe can be derived by purely deductive processes without making any supplementary assumptions of any kind, and without bringing in anything from observation. All of the conclusions reached in the theoretical development, including those with respect to the origin and properties of the quasars that were set forth in *Quasars and Pulsars* are therefore implicit in the fundamental postulates of the theory. If the postulates are valid, then quasars *must* exist, and they *must* have certain specific properties.

The question as to how a theory stands up when confronted with new additions to observational and experimental knowledge is very significant. Indeed, one of the most serious criticisms of current physical theory is that it is continually being faced with new discoveries which it did not anticipate, and with which it cannot cope without replacing or drastically modifying some of its components, an expedient that is feasible because current theory is not a single integrated structure of thought. Rather, as described by Richard Feynman, it is “a multitude of different parts and pieces that do not fit together very well”, and when one of these parts or pieces is found to be in conflict with new observational information the standard practice is to alter or replace it. But a purely deductive and fully integrated theory such as the Reciprocal System cannot be modified to agree with new observations. Such a theory can be *extended* into areas that were not previously covered, or it can be *corrected* if an error in the chain of deductions is found, but it cannot be *altered* to fit the empirical data. Consequently, when this new theory does agree with all of the new information, or at least is not inconsistent with any of it, as has been true in the quasar field during the past three years, this fact has more than the usual significance.

To a large degree, the center of attention in the three-year period has been the question as to the location of the quasars. At the time *Quasars and Pulsars* was published the consensus was strongly in favor of the “cosmological” hypothesis which holds that the quasars are actually at the full distance indicated if their redshifts are wholly due to the Doppler effect of the normal recession, and the dissenters, spearheaded by Dr. Halton Arp of the Hale Observatories, were fighting what appeared to be a losing battle. In the meantime, however, the momentum has shifted to some extent, and the article in the *New*

Scientist quoted earlier includes this statement. The latest quasar results... question further the conventional attitude to the redshift.” This questioning was much in evidence at the Canberra meeting of the International Astronomical Union in August 1973. As reported in the November issue of *Sky and Telescope*, “The most controversial subject was the interpretation of the galaxy redshifts, which a growing minority of astronomers believe are not a simple distance effect.”

But when we examine the evidence bearing on the question, there is actually nothing *definite* anywhere except the work of Arp that was analyzed in *Quasars and Pulsars*. All of the other reported findings, with two exceptions that will be discussed later, consist of agreement or disagreement, as the case may be, between the redshifts of objects whose projections on the sky are close enough to indicate that these objects *may* be contiguous. As a general proposition) a finding of this kind, a showing that *some* of the members of a given class conform to a specified relation, has little significance. It remains no more than speculative unless further work enables defining a subclass such that *all* of the members of this subclass conform to the specified relation.

The reason why the results obtained by Arp are conclusive, whereas the other findings are not, is that Arp has done what no one else has been able to do; that is, he *has* defined a class of objects, all known members of which *do* conform to a definite and specific redshift relation. In the Course of his studies of “peculiar” galaxies he found that certain galaxies which appear to have been subject to violent internal forces are bracketed by one or more pairs of radio emitting objects—quasars or radio galaxies—at distances and locations which suggest that these objects were ejected simultaneously in opposite directions from the disturbed central galaxies. These associations are not merely groups of objects whose observable positions indicate that they *may* be neighbors. They are groupings whose physical characteristics are similar and are in agreement with a plausible hypothesis as to their origin; that is, their identification depends not only on apparent proximity, but also on (1) abnormalities in the central galaxy (which are consistent with the assumption that it has exploded), (2) radio emission from the presumed ejecta (which is consistent with the assumption that they are products of an explosion), and (3) existence of the presumed ejecta in pairs at comparable distances and in positions on opposite sides of the central galaxy (which is consistent with the assumption that they were thrown off simultaneously in opposite directions).

Dr. Arp did not pursue the redshift issue in the original study beyond commenting that the existence of associations between quasars and ordinary galaxies makes it evident that there is a component in the quasar redshift in addition to that due to the normal recession, a non-velocity component, he suggested. Subsequently the redshift data available for these associations were analyzed by the present author, and the results of that analysis were presented in *Quasars and Pulsars*. As shown in that publication, complete redshift measurements were available for four of those associations identified by Arp that included quasars. Within a narrow range of variation that can be accounted for by known causes of deviation, the mathematical relation between the central galaxy redshift and the redshift of the quasar is identical in *all four* of these cases. In view of the wide dispersion of the values of the quasar redshifts in general, the probability that the redshift of any one quasar would fall within the relatively narrow range of deviation is less than one in a

hundred. The probability that all four would, by chance, conform to the same mathematical relation within this range of deviation is therefore in the order of one in a million.

But this is not the whole story. Beyond the distance at which the features of the central galaxy can be identified with certainty (according to Arp) it has still been possible to locate probable associations of the same kind in which measurements of the redshifts of the quasars and the radio galaxies can be compared. The necessary data are available for three such associations in which the redshift is approximately 1.00, and here again *all three* of the associations conform to the *same* mathematical relation between member redshifts that applies to the closer groups. The only discrepancy found anywhere in the analysis was in the data for the most distant grouping for which the redshifts are available, one in which the quasar redshift is 1.66, and since this is well beyond the limit of positive identification as an association of related objects we can legitimately disregard it. When the three associations in the neighborhood of redshift 1.00 are added to the first four, the probability that the agreement between the redshift relations in all of the groups is accidental drops to about one chance in a billion. The results of the analysis thus verify the reality of the associations and furnish *definite proof* that these is a specific mathematical relation between the redshift of a quasar and the normal recession redshift of an ordinary galaxy or radio galaxy at the same spatial distance as the quasar.

Furthermore, these results show that the additional redshift component which is present in the quasar redshift is due to *some physical mechanism that is specifically related to the normal recession*. The existence of two distinct components makes any hypothesis such as that of tired light” untenable, while the fixed mathematical relation between the two components rules out anything such as a redshift of gravitational origin which is independent of the recession. Here, then, is a case where astronomical observations unequivocally demand something that conventional physical theory cannot supply. This is not the kind of a situation so common in astronomy in which the observations merely *suggest* certain conclusions; the results of this analysis are specific and positive

As many prominent astronomers concede, the general lack of progress toward an understanding of the quasar phenomena is a clear sign that a revision of basic ideas is necessary. Now the redshift analysis identifies some of the specific features that an adequate theory must possess. It must provide some mechanism whereby galaxies explode and eject quasars; it must provide some explanation as to why the redshifts of these quasars include a component related to, but distinct from, the normal recession redshift; it must provide a means whereby this second component can be produced; and it must arrive at the precise mathematical relation between the two classes of redshifts that exists in the Arp associations.

All of these requirements are met by the quasar theory derived from the fundamental postulates of the Reciprocal System. The features that the observations demand are the *same* features that we find when we apply pure reasoning to the properties of space and time as defined in the postulates. A development of the necessary consequences of these properties, without introducing anything from empirical sources, leads directly to the existence of matter, and on further extension to the existence of the aggregates of matter,—stars, galaxies, etc. --that are the concern of astronomy. A continuation of the

chain of reasoning shows that matter is subject to certain processes which in the course of time eventually culminate in explosive disintegration, resulting in phenomena observationally recognized as Type II supernovae. Further development of theory reveals that these supernova explosions occur mainly in the interiors of the oldest and largest galaxies and build up the equivalent of a pressure in these structures. When the pressure exceeds the restraining force the galaxy explodes, ejecting at least two fragments in opposite directions, one or more at a speed less than that of light, and one or more with a speed greater than that of light. However, the ultra-high speed fragments are subject to gravitation in the same manner as any other material aggregates, and their net effective speeds are therefore less than that of light for a considerable period of time, during which a fast-moving galactic fragment is observable as a quasar.

The explosive event which is required by the theory produces exactly the kind of an association of three related objects—a central galaxy with a radio galaxy on one side and a quasar diametrically opposite—that Arp has identified in his studies. The ultra-high speed imparted to the quasar by the tremendous energy released in the galactic explosion results in an additional dimension of motion, producing a second redshift component, related to, but distinct from, the normal recession, as required by the observations, and the mathematical statement of that relation as derived from theory is identical with the relation between the measured values.

As brought out in *Quasars and Pulsars*, this one-to-one correspondence between the theoretical deductions and the observational results is maintained throughout the entire range of the quasar phenomena. In this connection, it should be noted that the difficulties which conventional theory is having with the quasars—those difficulties that have made “quasar” almost synonymous with “mystery”—are not due to a lack of knowledge about those objects, but to too much knowledge. It is easy enough to fit a theory to a few bits of information, and the scientific community currently claims to have a sound theoretical understanding of a number of phenomena about which very little is actually known. But, as Harlow Shapley remarked some years ago, facts are the number one enemy of theories, and a great many facts about the quasars have been accumulated. As a consequence, orthodox theory is currently in a position where any explanation that is devised to account for one of the observed features of the quasars is promptly contradicted by some other known fact. Against this background, the complete agreement between the new theory and the observations is all the more meaningful.

Some of the features of the account of the origin and nature of the quasars derived from the Reciprocal System of theory are in conflict with current thought, to be sure. For example, present-day theory sees no way in which the forces necessary to eject a galactic fragment can be built up within a galaxy. “Obviously a normal assemblage of stars cannot be hurled about like a snowball”, says Arp. But this merely reveals a weakness in current thought, as the observational evidence now available makes it almost certain that fragments *are* ejected under some circumstances; that is, they *are* hurled about like a snowball. Current astronomical literature is full of references to, and hypotheses dependent upon, ejection of “assemblages of stars” from galaxies. In explaining how this is possible, and indeed inevitable in the normal course of galactic evolution, the Reciprocal System is simply filling an existing conceptual vacuum.

Similarly, current scientific thought rejects the possibility of speeds in excess of that of light, although the investigators who are studying the “tachyon” hypothesis are questioning this dictum because they recognize the same point that became evident in the course of the present study; that is, the limit is imposed by *theory*, not by established facts. The only factual evidence available simply shows that a greater speed cannot be imparted to a material object *by a particular kind of a process*. This evidence does not indicate whether the observed limitation applies to-the possible speed or to the capabilities of the process, and the conclusions of the Reciprocal System, which support the latter view, are equally as consistent with the evidence as the currently favored interpretation. When the observations from other areas are examined carefully it will likewise be seen, as in the foregoing examples, that the conclusions reached by the new theory are consistent with all of the definitely established facts, even though some of them are in conflict with currently accepted theories or assumptions.

For the benefit of those who are reluctant to take such a seemingly drastic step as giving credence to a theory which involves motion at speeds greater than that of light, it may be well to point out that as long as *some* major change in basic theory is required in order to bring is into harmony with present-day knowledge—a need that is now widely recognized in astronomical circles, and has been definitely confirmed by the redshift analysis just discussed—the kind of a change that will disturb existing physical ideas the least is one such as this which applies only to the far-out regions in which difficulties of one kind or another are being experienced. Of course, in the long run these is no choice. Physical theory must conform to the way in which the universe actually behaves, whatever that may be. But for those who dislike making major changes these may be a certain amount of consolation in the fact that while the introduction of ultra-high speeds into the theoretical structure, as required by the concept of a universe of motion, revolutionizes our view of some of the less familiar phenomena such as the quasars, it leaves the great bulk of physical theory untouched.

As mentioned earlier, these have been two recent attempts to confirm the cosmological hypothesis as to the location of the quasars by means other than comparing the redshifts of presumably associated objects. One of these was by Bahcall and Hills (*Astrophysical Journal*, Feb. 1, 1973), who compared redshifts with brightness and arrived at results that were summarized in a news report as follows: “The point is simply that, by and large, quasars with large redshifts seem dimmer than those with small redshifts, just as we would expect if they are farther away.” This is of course, valid evidence against the “local” hypothesis, which asserts that the quasars are in, or have been ejected from, our own or some nearby galaxy, but it does not favor the cosmological hypothesis over the “intermediate” explanation arrived at observationally by Halton Arp and theoretically from the postulates of the Reciprocal System. On this intermediate basis the quasars with large redshifts *are* farther away—*much* farther away—even though not nearly as far away as the cosmological hypothesis would put them.

While the controversy over the related subjects of the nature of the quasar redshifts and the location of those objects in space has occupied the center of the stage during the past three years, the discovery of a number of additional quasars with very large redshifts is actually more important, both as a significant increase in observational knowledge and as

a further confirmation of the theoretical conclusions reached by application of the Reciprocal System of theory.

At the time the book *Quasars and Pulsars* was published, only one quasar redshift that exceeded the normal limit of 2.326 by any substantial amount had been reported. As pointed out in that work, the 2.326 redshift is not an absolute maximum, but a level at which conversion of the relative motion of the quasar to a different status, which it will ultimately assume in any event, *can* take place. Hence the very high value, 2.877, attributed to the quasar 4C 05.34, either indicated the existence of some process whereby the conversion that is theoretically able to occur at 2.326 is delayed, or else was an erroneous measurement. Inasmuch as no other data bearing on the issue were available it did not appear advisable to attempt to decide between the two alternatives at that time.

In the meantime some additional quasar redshifts above the normal limit have been measured, and the theoretical situation has been clarified. The new measurements give redshifts of 2.69, 3.40, and 3.53, for the quasars PHL 957, OH 471, and OQ 172, respectively. These observations confirm the existence of redshifts in the range between 2.326 and the absolute maximum, and the fact that all of the high values are *much* above the normal limit points at once to the nature of the process that is involved.

Because quasars with lower redshifts are less distant and therefore more readily detected, other things being equal, a quasar with a redshift only moderately above 2.326 is more likely to be found than one with a redshift much above this figure, if there is a continuous distribution of redshifts throughout this range. The fact that the only ultra-high redshift known in early 1971 was far above any value previously measured was merely suggestive of some departure from a continuous distribution, but when the next three discoveries also involved redshifts substantially above the normal limit it became rather obvious that these unexpectedly high values were not chance results. The maximum normal redshift can be increased slightly above 2.326 by random motion in three-dimensional space superimposed on the motions of the recession type to which the 2.326 limit applies, and the tabulation by Burbidge and O'Dell, *Astrophysical Journal*, Dec. 15, 1972, lists two such values, 2.36 and 2.39, for the quasars 4C 25.5 and 5C 02.56, respectively. The latter is apparently a rather peculiar object, and its redshift may be abnormal, but in any event, its excess of about 0.6 is probably close to the maximum that random motion can be expected to contribute. The observational data now suggest that there are no redshifts at all in the range just above 2.39; that is, the process which enables the recession to exceed the normal limit involves a jump to a considerably higher redshift level.

On this basis a continuation of the normal $z + 3.5 z^{1/2}$ redshift pattern beyond 2.326 is ruled out, and a process that modified the 3.5 coefficient of the second redshift component is required. Once we arrive at this conclusion it is immediately obvious how this modification can occur. It should be understood that the change which takes place at what has been called the conversion point is not a physical process affecting the quasar itself; it is a change in the observed character of the quasar motion relative to our location in space. Before the conversion point the relative spatial speed of the quasar is less than unity (the speed of light) by reason of the retardation due to gravitation. Beyond that point the gravitational effect disappears, the relative spatial speed assumes the maximum

value of unity, and further change of relative position takes place in time only. But since the gravitational effect does not vanish immediately, this is not a knife-edge transition, and the effective spatial speed can therefore exceed the normal limit by a small amount.

An unfamiliar process such as this change in the apparent nature of the relative motion can best be explained by means of an analogy. For this purpose, let us consider the behavior of sunlight at the horizon. Inasmuch as light is normally propagated in straight lines, the horizon constitutes a limit (analogous to the 2.326 redshift) beyond which the sun disappears from *our* view (analogous to the disappearance of the quasar when the spatial speed reaches unity) if the light continues to move in the normal straight line pattern. But under certain circumstances, the light is refracted by the atmosphere, and by virtue of this refraction process (analogous to the special conditions that exist at the 2.326 limit) we are able to see the sun for a limited period of time after it sinks below the horizon (this is analogous to being able to observe a quasar for a limited time, and distance, beyond that corresponding to the 2.326 redshift).

This additional recession beyond the normal limit necessarily involves an increase in the second term of the quasar redshift expression. But the quantity $3.5 z^{1/2}$ cannot exceed 2.00, for reasons explained in *Quasars and Pulsars*, and the required increase in this term must therefore be accomplished by a change in the numerical coefficient. This coefficient is not fixed; the normal value 3.5 is merely the result of probability considerations which divide a total of 7 equally between the two dimensions of the explosion-generated motion. When some other factor intervenes, such as the arrival at the 2.326 limit, where the only alternative to disappearance of the quasar is alteration of the probability distribution, the latter takes precedence; that is, when we can no longer see the quasar in the usual manner, if there is any other way in which we can see it, we will do so. Instead of the normal 3-3½ distribution, the division then becomes 4-3, 4½, 5-2, etc. This is the inverse of the modification of the distribution of the 7 total units which gives rise to the absorption redshifts of the quasars that are still below the 2.326 limit. In that case the effective factor is reduced below the normal 3½ value to enable the quasar to absorb more energy in a greater speed, whereas in the situation now under discussion the factor is increased above the normal 3½ value to enable delaying the conversion to an unobservable state.

On the foregoing basis, the redshift of a quasar follows the regular $z + 3.5 z^{1/2}$ pattern up to the normal limit at 2.326. At that point it jumps directly to a higher value corresponding to a greater distribution factor (hereafter designated as F), the normal recession remaining at .326. The possible redshifts immediately after the readjustment (that is, before any further outward movement of the quasar has occurred) are compared with the observed ultra-high redshifts in the following tabulation. All of the calculated values may be modified to a small degree by random motions of the kind previously mentioned.

ULTRA-HIGH REDSHIFTS

F	Calculated (zero z increment)	Observed	Indicated Increment	Quasar
4.0	2.61	2.69	08	PHL 957
4.5	2.90	2.88	-	4C 05.34

5.0	3.18			
5.5	3.47	3.40	?	OH 471
	3.47	3.53	.06	OQ 172
6.0	3.75			

After the readjustment it is possible to observe a further slow increase of the redshift (analogous to seeing the sun below the horizon) which results from a continuation of the normal recession only. When this recession increment is large enough (probably somewhere between 0.5 and .10) it initiates the conversion process and the quasar disappears. In the interim the observed redshifts exceed the tabular values calculated on the basis of a zero increment by the amount of the actual increment.

It should be emphasized that the jump from $F = 3.5$ to a higher value does not, in itself, involve any increase in distance. For example, a quasar with $z = 3.18$ ($F = 5.0$) is at the same location immediately after the readjustment as a quasar with $z = 2.326$ ($F = 3.5$). Inasmuch as the subsequent recession increment is limited to a very small amount, it follows that all quasars with $z = 2.326$ and above are at approximately the same spatial distance. This is the explanation of the seeming inconsistency involved in the observed fact that the brightness of the quasars with ultra-high redshifts is comparable to that of the quasars in the $z = 2.00$ range.

Although random motions and possible observational inaccuracies introduce some uncertainties, the tabulated figures enable us to draw some tentative conclusions as to the size of the recession increment, and consequently the progress which each of the observed ultra-high redshift quasars has made toward the conversion point. The .08 excess in the observed redshift of PHL 957 suggests that this quasar is quite far advanced and is nearing the point of conversion, whereas the lack of any increment in the redshift of 4C 05.34 shows it to be in an earlier stage, not much beyond the normal limit. OQ 172 is in an intermediate condition, while the status of OH 471 is uncertain.

A further check of redshift theory against observation is possible because absorption redshifts have been measured for two of the ultra-high redshift quasars. On the basis of the theory developed in *Quasars and Pulsars*, the magnitudes of the possible absorption redshifts at zero recession increment can be calculated by replacing the factor F applicable to emission with successively lower values. This mechanism involving a change in F operates in the same manner both above and below the normal 3.5 factor. The theoretical redshifts of the two quasars, calculated in this manner, are compared with the observed values in the following tabulation. Some additional values were reported for PHL 957, but these were characterized by the observers as less than "probable", and they have therefore been omitted.

ABSORPTION REDSHIFTS				
F	Calculated	Observed		
		4C 05.34	PHL 957	
4.5	2.90	2.88		
		2.81		

4.25	2.75	2.77	
4.0	2.61	2.59	2.66
3.75	2.47	2.47	
3.5	2.33		2.31
3.25	2.18	2.18	2.21-2.23
3.0	2.04		2.07
2.75	1.90	1.86	
2.5	1.76	1.78	

The 4C 05.34 measurements (Bahcall and Goldsmith, *Astrophysical Journal*, Nov. 15, 1971) include one value 2.81 for which there is no theoretical counterpart. Aside from this, the correlation with the theoretical figures is very impressive. The other seven observed redshifts agree with the calculated values within an average deviation of less than .02, which is comparable to the close correlation in the figures for the only other equally extensive system thus far located, that of PKS 0237-23, which was discussed in *Quasars and Pulsars*.

There are no unexplained redshifts in the “probable” list for PHL 957. The lower measurements for this quasar agree with the theoretical values within the range of deviation that can be explained by random motions, as is to be expected since there is (by definition) no recession increment at or below the normal limit. The deviation of the one absorption redshift observed in the range between 2.326 and the emission value is about double the average deviation in the lower range, indicating that there is probably a recession increment here, instead of, or in addition to, random motion. This lends support to the conclusion expressed earlier that the .08 excess in the PHL 957 emission redshift is evidence of a recession increment, and that this quasar is therefore in a relatively late stage.

It is also evident that these absorption data confirm the validity of the theoretical explanation of the nature of the ultra-high emission redshifts. The continuity of the absorption redshift pattern all the way from $F + 4.5$ to $F - 2.5$ shows that the redshifts above the normal limit do, in fact, result from modification of the distribution factor F in the manner specified, while the agreement between the PHL 957 values and those for 4C 05.34 verified the theoretical finding that the increase in the normal recession beyond 2.326 is limited to a relatively small increment. The following comment from the Burbidges in their book *Quasi-stellar Objects* (1967) is prophetic:

We have gone into considerable detail in describing the absorption lines in the spectra of QSO's, because these may in the end provide more clues for solving the problem of the nature of the QSO's than do the emission lines.

One of the reports of observations made on PHL 957 includes the comment that the most striking feature of the absorption spectrum of this quasar, a “very broad line”, corresponds to $z = 2.309$. This is, of course, the normal limiting value 2.326 with a small

random motion modification, and it is not surprising that it is prominent. It *is* somewhat surprising, however, that this value does not appear in the list of observed absorption redshifts for 4C 05.34, and it will be of some interest to see if it shows up when further observations of this quasar are made. This absence is all the more striking in view of the presence of 90 many redshifts at intermediate factors (3.25 etc.). Previous studies of absorption redshifts reported in *Quasars and Pulsars* indicated that these intermediate factors are normally encountered only at the lower end of the range of values, the high energy end). The PHL 957 redshifts conform to this general rule, but the intermediate values are prominent throughout the entire redshift range of 4C 05.34. However, the great spread of these absorption redshifts—all the way from factor 4.5 down to 2.5—shows that this quasar is literally blowing itself apart, and this no doubt accounts for the multiplicity of redshifts, as in such a violent environment almost any possible situation will be realized.

In case there is any question as to why this quasar (4C 05.34) is the one that is apparently nearing the time when it will be so badly disintegrated that it will cease to exist as a physical object, while PHL 957 is apparently the one that has progressed farthest toward the point where its relative motion will convert to the zero time datum and the quasar will become unobservable, it should be explained that two different processes are involved. The ultimate demise of the quasar is simply a matter of *age*. When the great majority of the stars that constitute the fast-moving galactic fragment that we call a quasar have reached the age limit of matter and have individually disintegrated, the quasar ceases to exist as such, irrespective of where it may be at that time. On the other hand, the disappearance of the quasar at the conversion point, the point at which its motion relative to our location in space changes character, is a matter of *distance*, and it is dependent on both the initial location, the scene of the galactic explosion, and on the amount of time during which it has been receding since that initial event. A quasar that originated at a distant location may therefore reach the conversion point in somewhere near its original condition, whereas one that originated nearby may disintegrate before it ever arrives at the point of conversion. The disintegration, unlike the conversion, is a definite physical event. When PHL 957 passes out of our ken it may still be observable from some other galaxies that were closer to the scene when the original explosion that produced this quasar occurred, but when 4C 05.34 is reduced to debris its existence as a quasar will have terminated.

Aside from the measurements on PHL 957 and 4C 05.34, the new absorption redshift data accumulated during the three-year period under consideration have been confined mainly to values comparable to the emission redshifts. However, two measurements that have been reported for the quasar PKS 0812+02 are of special interest because this is the first quasar with a redshift below 1.00 for which a clear-cut comparison of a series of observed absorption redshifts with the corresponding theoretical values could be made. As indicated in the following tabulation, two of the possible steps below F - 3.5 have been activated in this quasar, making it possible to demonstrate more conclusively that the absorption redshift theory which is here being discussed is applicable to the lower redshift ranges as well as to the higher values.

ABSORPTION REDSHIFTS - PKS - 0812+02

F	Calculated	Observed
3.5		.402 (em)
3.25	.374	.384
3.0	.346	.344

Another new development in the redshift area since the date of the previous publication is the discovery of an absorption redshift in the radiation at radio frequency from the quasar 3C 286. This has generated considerable interest because of an impression in some quarters that the radio absorption requires an explanation different from that applicable to absorption at optical frequencies. Brown and Roberts, who made the original observations, conclude that the redshift is due to absorption by neutral hydrogen in some galaxy lying between us and the quasar. Since the absorption redshift is about 80 percent of the emission redshift of the quasar, they regard the observations as evidence in favor of the cosmological redshift hypothesis. (This is the second of the two cases in which attempts have been made to bolster the cosmological hypothesis by means other than the usual correlations between the redshifts of presumably associated objects.)

On the basis of the Reciprocal System of theory the radio observations do not introduce anything new. The absorption process that operated in the quasars is equally applicable, according to that theory, to *all* radiation frequencies, and the existence of an absorption redshift at radio frequencies has the same significance as the existence of an absorption redshift at optical frequencies. Furthermore, the values of the radio redshifts are subject to the same considerations as those of their optical counterparts. The emission redshift of 3C 286 is .849. Calculation by the method explained in *Quasars and Pulsars*, and utilized in deriving the theoretical redshifts earlier in these pages, establishes the first three possible absorption redshifts below the emission value for a quasar of emission redshift .849 as .79, .735, and .68. As the observed value of the radio redshift is .69, the agreement with theory is complete.

At the time *Quasars and Pulsars* was released for publication, the available absorption redshifts, other than those in the immediate vicinity of the emission values, were confined to the range of redshifts which we may call the normal high redshift region, just below the normal limit at 2.326. The results of the comparison between an these data and the calculated values were summarized in the book as follows:

Although the amount of observational information available for correlation with the theoretical deductions is small, the agreement is so close that it constitutes a rather strong case in favor of the theoretical development.

As demonstrated in the foregoing paragraphs, the additional measurements reported during the past few years have enabled extending these correlations to a much wider field—to the ultra-high redshift region beyond the 2.326 limit, to the relatively low redshift region below 1.00, and to the radio frequency region. Inasmuch as the agreement between the theoretical and observed values is equally as satisfactory in these new areas as in the redshift region covered in *Quasars and Pulsars*, the “rather strong case” has become very much stronger. As matters now stand, it is almost as conclusive as the results of the analysis of the redshifts in Arp’s associations. Taken together (and they

must be considered together, as they are based on the same conceptual foundations and the same mathematics) they should be decisive.

One of the important results of the application of the Reciprocal System of theory to the quasars is the finding that these are two distinct classes of radio-emitting quasars with quite different properties, separated by a long radio-quiet period. The internal activity of a Class I quasar, one that has just recently (in the astronomical sense) been ejected from the galaxy of origin, results mainly from the energy imparted to it by the galactic explosion in which it originated. When this activity subsides the quasar enters the radio-quiet period. Later, its constituent stars begin to arrive at their age limits, and explosions of these stars renew the internal activity. As soon as this is sufficiently energetic, radio emission resumes on the Class II basis.

The most distant quasars now known are all Class II objects, as the Class I quasars are not currently observable at these immense distances. Below a redshift of about 1.00, however, both classes are presents and in order to distinguish one from the other it is necessary to utilize some measurable properties in which there is a systematic difference between the values applicable to the two classes of objects. Ultimately it should be possible to establish such lines of demarcation from pure theory, but for the present this must be done empirically, and tentative criteria were defined in *Quasars and Pulsars* on the basis of the magnitude of the radio flux and the U-B color index. The additional information accumulated in the intervening three years now makes it possible to review this situation with the dual objective of increasing the accuracy of *the* lines of demarcation between the two quasar classes and at the same time demonstrating the agreement between theory and observation that exists in areas not covered in the earlier publication.

It will be convenient to begin this review with a consideration of the limitations to which the occurrence of absorption redshifts in the quasars is subject. From theoretical premises we have previously deduced that the absorption which gives rise to the absorption lines in the quasar spectra takes place in concentrations of material thrown out in the course of internal explosions in these objects. No absorption exists, therefore, until the explosions occur on a sufficiently large scale. As noted earlier, this point is not reached until the quasar is somewhere in the radio-quiet stage, while it is evident from the nature of the requirements for the production of multiple absorption redshift systems that multiplicity will not appear until a still higher level of activity is reached. On the basis of this evolutionary pattern we can deduce the following rules regarding the occurrence of absorption redshifts:

1. Class I quasars have no absorption redshifts.
2. Absorption redshifts approximating the emission values are possible throughout most of the radio-quiet region, as well as in the Class II quasars.
3. Absorption redshifts differing from the emission values by more than the amount that can be attributed to random motion are possible only in Class II quasars and relatively old radio-quiet quasars.

A review of the absorption redshifts listed in the compilation by Burbidge and O'Dell was carried out for the purpose of testing the validity of these rules. In order to maintain a continuity with the correlations between theory and observation that were presented in the previous publication, the radio and optical data utilized in the current analysis were taken from the same sources as before, and the same limiting values were applied in determining the class of quasar. On this basis there is no violation of Rule 3, but three of the 29 quasars with absorption redshifts appearing in the reference tabulation are in violation of Rule 1. This is, of course, too large a discrepancy. As stated in *Quasars and Pulsars*, there is a theoretical possibility of some rare exceptions to rules of this kind based on the normal pattern of quasar evolution, because there is a chance that the galactic fragment which is ejected as a quasar may contain a substantial number of old stars, in which case the normal time schedule will be anticipated. One deviant out of the 29 might be explained in this way, but not 3.

Examination of the measured values leads, however, to the conclusion that the difficulty lies in the original criteria by which the two classes of quasars were distinguished. The radio emission and color measurements (with one value missing) indicate that all three of the doubtful quasars are similar in their characteristics; that is, all three are in the region of high U-B values and low radio emission. This suggests that while the line of demarcation between Class I and Class II shown in the diagrams in *Quasars and Pulsars* is probably somewhere near correct in the low U-B region, it needs to be modified in the region of high (more negative) U-B values. Like all other empirical products, this boundary line is subject to change when more information becomes available.

A study has indicated that the necessary adjustment of the selection criteria can be accomplished by introducing the B-V color index into the classification system. (This is equivalent to defining areas on a two-color diagram such as Fig. 2.1 in the Burbidge book *Quasi-stellar Objects* from which the data used in establishing the original lines of separation were taken.) The available B-V measurements for the three quasars that, on the basis of the presence of absorption redshifts, belong in Class II, are in the upper portion of the full range of values, whereas those of the relatively low redshift quasars in this region, which can be expected to be mainly Class I objects, fall principally in the lower portion of the range. We may tentatively establish a dividing line at +.15, and instead of assigning all of the quasars with low radio emission and high U-B values to Class I, we will put the members of this group that have B-V indexes above +.15 in Class II.

Until such time as we are able to base the selection criteria on a theoretical rather than an empirical foundation we can hardly expect precision, but the change to two-color standards undoubtedly brings us closer to the correct line of demarcation, as all of the quasars with absorption redshifts now fall in class II, as required by theory, whereas all but one of those in the region under consideration that have emission redshifts below .350 fall in Class I, as most of them theoretically should. The importance of being able to distinguish between the two classes of quasars on the basis of the color indexes and radio emission lies in the fact that this makes it possible to check the validity of the theoretical conclusions that are reached with respect to other features of these objects, such as the rules with respect to the occurrence of absorption redshifts. After the criteria are changed

as indicated above, the 29 quasars in the reference list are all in conformity with the rules as stated.

This successful use of the B-V color index to improve the distinction between the two classes of radio-emitting quasars in the region in question naturally suggests extending consideration of the behavior of this index to an examination of the entire pattern of the variations that take place during the course of evolution of the quasar, a subject that was not investigated in the study that produced the results reported in *Quasars and Pulsars*. It was mentioned by the Burbidges that the astronomers recognize a systematic, but “rather complicated” relation between the spectral colors of the quasars and their redshifts. Theoretical considerations indicate that the true relation is between color and internal activity. The internal activity of an average quasar of each class is a function of its age, and the average age, in turn, is related to the distance. Thus there is a theoretical basis for the astronomers’ finding; that is, there actually is a somewhat loose relationship between the color indexes and the redshift (distance).

The principal reason for the “rather complicated” nature of the relations indicated in the Burbidge Figs. 4.4 and 4.5 is the lack of differentiation between the two classes of quasars. When the classes are separated, most of the complexity disappears, although there is still a large scatter of the values because the relation between color and redshift is indirect and only approximate. The correlation between age and distance depends on the fact that the quasars are continually moving outward, but explosive ejections occur at distant, as well as nearby, locations, and individual quasars may therefore be considerably younger than the average quasar at the same distance. In Class I there are also variations in internal activity due to differences in the magnitudes of the galactic explosions in which the ejections took place, while in Class II both the time of onset of the secondary explosions and their rate of development are variable. Nevertheless, there is a definite general pattern. “The systematic nature” of the color-distance relation, say the Burbidges, “is apparent”.

The U-B index was discussed in *Quasars and Pulsars*. As brought out there, the initial range of this index immediately after ejection is from -0.40 to -0.50 . As these Class I quasars age, the index gradually moves toward values in the range from -0.75 to -1.00 . No systematic variation of this U-B index was found in the Class II quasars.

The B-V indexes of the earliest Class I quasars that have been observed are in the range from $+0.40$ to $+0.60$. Like the U-B index, the B-V value gradually moves in the negative direction with increasing age, and those quasars that are approaching the radio-quiet stage have indexes below $+0.10$, extending to negative values in some instances. The B-V index for most of the Class II quasars with relatively low redshifts (below 0.750) are in the neighborhood of $+0.20$. Beyond 0.750 the index increases, and maximum values around $+0.60$ are reached between 1.00 and 1.40 redshift. This maximum is followed by a rather rapid drop to a level in which most values are comparable to those of the early members of this class.

While the actual mathematical relation between the internal activity of the quasars and their color indexes has not yet been examined from the standpoint of the Reciprocal System of theory, the pattern followed by the values of these indexes, as described in the

preceding paragraphs, shows a definite qualitative correlation with the changes that theoretically take place in the generation and dissipation of energy. In Class I the initial activity is high, but it gradually subsides, as no continuing source of large amounts of energy is available to these objects. Both color indexes respond to this change by moving toward more negative values as the quasars age. In Class II the initial activity develops slowly, as it originates from many small events rather than one big event, and the early values of the B-V index are about the same as those of Class I quasars of medium age. However, the internal energy of the Class II quasars *increases* with age, as additional stars continue to arrive at the destructive limit. The B-V index therefore moves toward more positive values, reaching maximum levels in the redshift range from 1.00 to 1.40 that are comparable to those of the early Class I quasars.

Beyond 1.40 redshift the motion of the average quasar undergoes a change, the readjustment that is responsible for the appearance of absorption redshifts, which are present in most quasars beyond $z = 1.40$ but are relatively rare at the shorter distances. Inasmuch as this change, which distributes a somewhat greater total energy over a larger number of motions, reduces the energy *concentration*, the B-V index drops to a level approximating that of the early members of Class II. The U-B index does not seem to be sensitive to the events that take place in the evolution of the Class II quasars, and, as stated earlier, shows no systematic change.

At the time *Quasars and Pulsars* was published it did not appear that the available observational information regarding the internal structure of the quasars was extensive enough or accurate enough to justify any attempt at a theoretical explanation of the various structural features. Of course, the theoretical conclusions are independent of empirical information, and it would be possible to proceed with the deductions from theory in advance of the observations, but, as a practical matter, there is not much to be gained by arriving at theoretical answers to outstanding questions unless (1) the theory is already firmly established, or (2) enough observational data are available to enable a demonstration that the theoretical results are in accord with the physical facts. It cannot be claimed that the Reciprocal System of theory is, as yet, firmly established in the eyes of the scientific community (although there is abundant evidence to prove its validity when that community gets around to examining it in detail), and the policy that has been followed in the development of the details of the theoretical system has therefore been to confine the work to phenomena on which enough information is available to verify the validity of the theoretical conclusions that are reached. However, the situation in the observational area changes as time goes on, and inasmuch as the scope and accuracy of the observations of the structural features of the quasars have been substantially improved in the last few years, a preliminary theoretical consideration of this subject would seem to be in order at this time.

It is clear, from a theoretical standpoint, that the factor which determines the internal structure of the quasars is the existence of two quasi-independent populations of stars and particles. At the time of ejection, the quasar as a whole is moving at a speed in excess of that of light, although the spatial speed relative to our location is, for the time being, reduced to a level below that of light by the opposing gravitational motion. The violence of the ejection has also had an effect on the individual speeds of the material aggregates

within the quasar, and some of the constituent stars and particles are now moving at ultrahigh speed, while others retain the lower speeds that prevailed while the object that is now a quasar was still a part of the outer structure of the galaxy of origin. There is some contact between these two populations, but the contacts are minimal, for reasons explained in earlier publications, and energy equilibrium is established for each population independently. At this early stage of its development, therefore, the quasar is a two-component system, with ultrahigh particle speeds in one component and speeds less than that of light in the other.

In order to understand the consequences of the existence of those two dissimilar components a consideration of the theoretical background will be necessary. According to the postulates of the Reciprocal System of theory the physical universe is composed *entirely* of motion, that term being used in what we may call the scientific sense, which defines it as a relation between space and time, measures it as speed or velocity, and represents it in mathematical symbols by the "equation of motions. In its simplest form that equation is $v = s/t$. Only two physical restrictions are placed on motion by the postulates: (1) that it is limited to three dimensions, and (2) that it exists only *in* discrete units.

In such a universe, where there is *nothing but* motion, space and time have no significance other than their status as the two reciprocal aspects of that motion. At the basic level, where no physical activity is taking place and nothing exists but individual units of motion, each such unit is a relation between one unit of space and one unit of time. In their capacity as the reciprocal aspects of these units of motion, the only significance that they possess, the *units* of space and of time are therefore *moving* units. Consequently, the natural reference system, the datum from which all physical activity extends, is not a stationary system, as heretofore assumed; it is a *moving* system. In the absence of physical activity the universe is not at rest; it is in motion at unit speed. Every location in the physical universe, together with any object that may be occupying such a location, is continually moving outward from every other location at this speed: one unit of space per unit of time.

This substitution of a moving system of reference for the familiar stationary reference system is the first of the major conceptual revisions that are required in order to view physical phenomena in the content of a universe of motion. Mental reorientation of this nature is, of course, difficult. As Herbert Butterfield puts it, "Of all forms of mental activity, the most difficult to induce... is the art of handling the same bundle of data as before, but placing them in a new system of relations with one another by giving them a different framework." But there is no alternative. Where science has been looking at physical phenomena in the wrong way, the prevailing viewpoint must be altered before the picture can be seen in its true light.

The way in which the concept of a moving system of reference gives us an altogether different view of many physical relations is well illustrated by its application to the recession of the distant galaxies. According to conventional theory, an object at rest in the universe is motionless with respect to a stationary reference system. In order to explain the recession on this basis it is necessary to provide some means whereby the galaxies could have been accelerated to their present speeds, and since there is no known process

that is anywhere near adequate for this purpose a most extraordinary event has been postulated, a catastrophic “big bang” that has hurled the galaxies out into space. In a universe of motion, on the other hand, the recession is a direct result of the basic nature of the universe, and the only thing that needs to be explained is the lower recession speed of the lower galaxies.

This explanation does not require an implausible *ad hoc* assumption such as that which is the basis of the “big bang” hypothesis. The lower speed at shorter distances is the result of a retarding effect that we *know* is present, that of gravitation. As shown in detail in *Quasars and Pulsars* and previous publications, gravitation in a universe of motion is an inherent property of the combinations of motions that we recognize as matter, and is itself a motion (as, of course, it must be) similar to the recession in its general nature, but negative rather than positive. The net effective motion of any object is therefore determined by the relative magnitudes of the opposing inward and outward motions. In our immediate environment gravitation predominates, but inasmuch as its effect decreases with distance there is a point beyond which the net motion is outward, and the more distant galaxies therefore recede from our location at speeds that increase with distance, reaching a major fraction of the speed of light at the extreme range of present-day instruments.

As can be seen from this explanation, the recession is inherently a *scalar* motion, simply outward. Gravitation is an inward motion of the same character. The approximate equality between these two opposing motions that exists in our local environment makes it possible to set up an arbitrary reference system in which measurements are made from a zero motion base. Such a reference system enables recognition of the three-dimensionality of physical existence, and makes it possible to assign spatial *directions* to the inherently scalar recession and gravitational motion (as well as to other more complex motions that are inherently vectorial). However, this stationary three-dimensional spatial reference system does have a serious defect in that it is limited to the representation of spatial positions, and provides no means whereby changes of position in time can be taken into account. In utilizing it we are therefore tacitly assuming that no such changes occur, other than those due to the omnipresent time progression.

The results obtained on the basis of this assumption are accurate at low speeds, where changes in time location relative to the natural moving datum are negligible, but serious discrepancies are introduced at high speeds (this is the origin of the difficulty that the relativity theory was designed to overcome), and the reference system breaks down altogether in application to speeds beyond the unit level (the speed of light). There is no way in which such speeds, or the changes in location that result therefrom, can be represented in a three-dimensional coordinate system.

The concept of phenomena which either cannot be represented accurately, or cannot be represented at all, within a three-dimensional spatial system of reference, will no doubt be unacceptable to many individuals who are firmly committed to the long-standing belief that the region defined by such a system is the whole of physical existence. But this is simply another case of anthropomorphism, not essentially different from the once general conviction that the earth is the center of the universe. Nature is under no obligation to conform to the manner in which the human race perceives physical events,

and in order to enable continued progress toward better understanding of natural processes it has been necessary time and again to transcend the limitations that men have tried to impose on physical phenomena. Extension of physical theory into regions beyond representation in the conventional reference systems is a drastic move, to be sure, but the fact that such an extension turns out to be required when we place our system of theory on the sound conceptual foundation provided by the idea of a universe of motion should not surprise anyone who is familiar with the history of science.

The salient point here is that because it is a universe of motion, with all of the latitude that is made possible by the versatility of the motion concept, the physical universe is much more extensive than the reference system into which conventional scientific thinking tries to force it. Of course, there is no *a priori* reason why the physical universe must necessarily be a universe of motion. But a development of the consequences of the postulates that define such a universe has demonstrated that those consequences are completely in accord with the observed properties of the physical universe, thereby establishing that this physical universe is, in fact, a universe of motion. Naturally, the change from the definitely untenable concept of a universe of matter to that of a universe of motion calls for some modification of fundamental ideas, and in order to gain a clear understanding of the new theoretical picture the various features thereof must be viewed in the context of this “different framework”, as Butterfield calls it. The first essential is to relate all basic physical phenomena to the moving, rather than the stationary, system of reference.

A major result of this change of reference system is elimination of the infinities that appear when present-day physical theories are carried to their limits. These infinities are the despair of the physicists. “We have all these nice principles and known facts, but we are in some kind of trouble”, says Feynman (*The Character of Physical Law*, 1965), “either we get the infinities or we do not get enough of a description.” He recognizes that *something* in current thought must be wrong, and he can see that the error probably lies in some basic assumption, but he admits that he and his colleagues are at a loss to say what it actually is: “We really do not know exactly what it is that we are assuming that gives us the difficulty producing infinities.” The finding that the natural system of reference in the physical universe, a universe of motion, is a *moving* system now provides the answer to this “nice problem”, as Feynman calls it. The conceptual error that is causing the difficulty, the erroneous assumption that underlies conventional physical theory, is the assumption that the datum from which physical activity extends is zero. The infinities result from this error; they are man-made. They do not exist in nature, because nature knows neither zero nor infinity (other than the *net* resultant of zero that is produced by the interaction of equal and opposite motions). Physical activity in a universe of motion is limited to the range from $1/n$ to $n/1$. Zero, One, and infinity, $n/0$, are both physically impossible, as neither time without space nor space without time can exist in a universe in which there is *nothing but* motion.

Another of the major conceptual changes that are necessary in order to comprehend what happens in a universe of motion is a revision of previous views as to the relation between space and time. In motion, these two entities are reciprocally related, as expressed in the equation of motion, $v = s/t$. Where nothing but motion exists, this is a *general* relation;

that is, space and time are reciprocally related *everywhere* in a universe of motion. Since all physical entities and phenomena in such a universe are motions or combinations of motions, they are combinations of space and time in different ways and in different proportions. One of the important consequences of the general reciprocal relation is that for each of these entities or phenomena there exists another that is exactly the same in all respects except that space and time are interchanged. Inasmuch as unity is the boundary between n and its reciprocal $1/n$, it also follows that the space-time relations are inverted whenever and wherever this boundary is crossed in either direction.

Lack of recognition of this inversion at unit levels is responsible for many errors in conventional physical theory, and is one of the principal reasons why science has not been able to achieve the same degree of success in dealing with recent discoveries in the realms of the very small, the very large, and the very fast that has characterized the results in the more familiar regions of the universe, which are within the unit boundaries and therefore not subject to the inversions. In most cases, the physical effects of the inversions have been observed, but they have been misinterpreted. The current belief that speeds in excess of the speed of light are impossible is a typical example. In a universe of motion, the true explanation is not that a speed of unity (the speed of light) cannot be exceeded, but that the space-time relations of the physical phenomena related to the speed are inverted at the unit level. A *spatial* speed greater than that of light is impossible, not because there are no greater speeds but because the greater speeds are *temporal* speeds; that is, they cause change of position in time rather than change of position in space.

A similar inversion is responsible for the generation of radiation at radio frequencies in the quasars and related objects. In order to avoid the confusion that might result from introducing too many unfamiliar ideas at the same time, the source of this radiation was not identified in the discussion in the earlier pages, other than by the rather vague expression "internal activity." At this time, however, it is appropriate to point out that the "internal activity" of the quasars is *inverse* radioactivity. The radio flux consists, at least mainly, of inverse gamma rays: radiation with frequency $1/n$, where n is the frequency (in natural units) of the corresponding gamma rays. This situation was discussed briefly in *Quasars and Pulsars*, but some additional comments are now in order inasmuch as the problem of accounting for the energy output from the quasars is the most difficult issue facing any theory that undertakes to explain these objects.

No advance at all has been made in this respect by the physicists and astronomers working along conventional lines. The position of conventional theory has, in fact, deteriorated in recent years, as the greater redshifts that have been located imply a still further increase in the maximum energy output, which was already far beyond any possibility of explanation within the bounds of orthodox physics. There is no lack of appreciation of the seriousness of the situation. Simon Mitton, for instance, tells us that, at the present time, the so-called 'energy problem' (in the quasars) is widely considered to be the most important unsolved problem in theoretical astrophysics." But it gets comparatively little attention in present-day practice, simply because, in the context of current thought, there is no way of even approaching the problem of generating the stupendous amount of energy that appears to be required.

In the context of the Reciprocal System of theory there is no problem. On this basis, the energy requirements are very much lower, as the quasars are not anywhere near as far away as conventional theory would put them, while at the same time the existence of a hitherto unknown source of large quantities of radiant energy is disclosed. Explosions of the kind that occur as Type II supernovae reduce a portion of the stellar material to energy and accelerate most of the remainder to ultra-high speeds. At these speeds beyond the unit level the factors that govern atomic stability are, like all other properties related to the speed, inverted. Under low speed conditions, the zone of stability in the normal galactic environment is above the basic level at which the atomic weight is twice the atomic number. At ultra-high speeds the direction of the mass increment is reversed, and the zone of stability is below the basic level. This makes no difference in the case of a light element, because the deviation of its atomic weight from the basic level is negligible. But for the heavy elements the change is substantial, and radioactive ejection of mass is necessary in order to reach the new zone of stability. Inverse gamma rays (radiation at radio frequencies) are emitted during this process, just as normal gamma rays are emitted during the more familiar radioactivity of the low-speed region.

Thus it is not necessary to assume the existence of exotic physical processes to account for the radio emission from astronomical objects. Wherever Type II explosions occur—in quasars, in the interiors of the giant elliptical galaxies, in the cores of the Seyfert galaxies, in the central portions of smaller and younger galaxies such as our own, and in isolated stars throughout all galactic aggregates—inverse radioactivity takes place and radiation at radio frequencies is emitted. The reason for the dependence of the quasar radiation pattern on the “internal activity” is therefore apparent.

Inversion at the unit level likewise explains the special characteristics of the second unit of quasar motion. When the enormous amount of energy released in a galactic explosion ejects a fragment of the galaxy, a quasar, at a speed in excess of that of light, this involves crossing the boundary of the region of unit speed. Beyond unit speed the quasar is no longer moving in space, but in time. However, the relation between the zero space datum and the zero time datum is such that this motion in time has a specific spatial effect, which has been described in previous publications as a motion in equivalent space. As therein explained, these two zero levels are separated by the equivalent of eight units; that is, if the time magnitude is one unit, the equivalent space magnitude is seven units. (This is a relation of wide applicability. For instance it accounts for the primary valence pattern in chemical compounds, where an element with a negative (space) valence x , such as sulfur in CS^2 , has a positive (time) valence $8 - x$, as in SF^6 .)

By reason of this relationship, a quasar which passes the unit boundary and acquires a unit of motion in time is moving at a rate of seven units in equivalent space. Half of these seven units are coincident with the normal recession (except near the 2.326 limit, where the distribution of the seven units may be altered, as explained earlier). This coincident portion of the motion in equivalent space does not result in any actual change in spatial position, but it does enter into any phenomenon such as the spectral redshift which is related to the total amount of motion rather than to the spatial motion alone, and it also has a bearing on the amount of movement in space that results from the interaction of the quasar motion and gravitation. This, in brief, is the theoretical basis for the treatment of

the external aspects of the quasars in *Quasars and Pulsars*, and in the previous pages of this extension of that work.

Now we are concerned with the internal aspects, and the first significant point that comes to light is that, in its early stages, the quasar contains two distinct components with very different particle speeds. Ordinarily we think of the motions of the constituent particles of an aggregate as being distributed in all directions, so that the effect on the speed of the aggregate as a whole is zero, but vectorial direction has no meaning in application to speeds in excess of unity. All of the components of the total motion of the quasar are purely scalar—simply outward (which is the reason why they produce no blueshifts). Consequently, the difference of one unit between the particle speeds of the two populations within the quasar means that they are moving apart.

Since the quasar as a whole is already moving at a speed of two units, the addition of an internal unit brings the total speed of the faster particles up to three units. As brought out in the previous discussion, the second unit of motion is collinear with the first, and the explosion component of the total quasar speed, $3.5 z^{1/2}$, adds to the normal recession speed z . This is possible because a two-unit change in speed, from one unit in the spatial direction (+1) to one unit in the temporal direction (-1) does not result in a net total speed in excess of one unit at any point, and hence such a change is within the limitation imposed by the discrete unit postulate. But the existence of more than two collinear units would conflict with that postulate, and is therefore excluded. Hence the third unit of motion, the level of the individual motions of the stars and particles that constitute the ultra-high speed component of the quasar, is necessarily perpendicular to the line of the recession, and instead of manifesting itself as an additional outward motion in our reference system (an addition to the redshift) it appears as a lateral displacement.

In the context of our three-dimensional frame of reference, the lateral displacement acquires a direction, but the reference system only identifies the line of motion, and does not specify which way the object is moving along that line. The latter, so far as the reference system is concerned, is purely a matter of chance, and since the probabilities are equal, the ultra-high speed material will, in the absence of physical interference, be distributed equally between the two lateral directions.

Because of the inherently non-directional nature of a scalar motion, its apparent direction is relative to the location of the observer. The net magnitude of the observed change of radial position also depends on the observer's location, by reason of the attenuation of the gravitational effect with distance. From our viewpoint, distant galaxy X is receding in a certain direction at a high speed (that is, a high value of the redshift z). To an observer in galaxy A, closer to X, the observed speed of X is lower, and the direction of the motion is totally different, while to an observer in galaxy B, quite near X, galaxy X is not moving at all. The same is true of the observed values of the explosion component of the quasar speed (the second component), which has the same directional characteristics as the normal recession, and differs mainly in the observed magnitude ($3.5 z^{1/2}$ instead of z).

Now we are considering a third scalar motion that is lateral rather than radially outward, and has a magnitude differing from both of the other recession components. Here, again, the observed speed, and consequently the position, depends on the location of the

observer. To us, there is a separation between the ultra-high speed and low speed components, and the quasar appears as three objects (one optical and two radio) in line, whereas to the nearby observer in galaxy B there is no separation. He sees only one object. The basic principle that governs this situation is that, in observing scalar motion, either radial or lateral, the observer sees only the net difference between the actual outward motion of the observed object (away from the observer) and his own inward gravitational motion (toward the object), the magnitude of which varies inversely with the distance. It should be noted that from the scalar standpoint the lateral displacement is outward, and the inward motion of gravitation opposes this displacement in the same manner that it opposes the outward radial motion. This is another of the places where the conventional three-dimensional system of reference is not capable of giving us a true picture of the actual situation.

All of the radiation from the quasar is subject to the same considerations, but the optical radiation comes mainly from the low speed matter, and the radiation at radio frequencies comes mainly from the ultra-high speed matter. The optical observations therefore see the quasar at the undisplaced location, while, in the simplest situation, where there is a fairly complete separation of the components, the radio observations see it in two areas that are equidistant from the center of mass and diametrically opposite each other. In this case the total radio emission is divided equally between the two outlying locations.

Since the segregation of the two components is usually incomplete, and may be very irregular, deviations from this simple pattern are common. If enough of the ultra-high speed matter remains intermingled with the low speed aggregate to result in an appreciable radio emission from the optical location, or if there is a significant emission in the radio range from the low speed matter itself, the radio observations show three emission sources in line, rather than merely a double source. The prevalence of this pattern is indicated in the data reported by Macdonald and Miley (*Astrophysical Journal*, Mar. 1, 1971). These investigators say that only 6 of the 36 quasi-stellar objects for which they determined radio structures are definitely double, whereas 23 may have a third component at the center. The remaining 7 are more complex.

The more complex patterns result from irregularities in the initial distribution of the ultra-high speed matter and from non-central internal explosions. The symmetrical pattern that has been described prevails only where the center of mass of the ultra-high speed component coincides with the optical center, and any irregularities of the kind mentioned can therefore cause a deviation of the radio centroid from its optical counterpart. If the explosions are very energetic some rather drastic changes may occur, but more commonly the result is merely a displacement of the radio centroid along the normal lateral line. If the explosive activity is continuing, the matter newly elevated to the ultrahigh speed status by the explosive release of energy will move outward to one or both of the normal positions of the ultra-high speed component, but a finite time is required for completion of this movement, and in the interim a jet of material (or perhaps two in opposite directions) will be observed moving outward along the line of the radio sources. Where there are intermittent bursts of explosive activity, concentrations, or "knots", of matter will be seen in the jets.

Because of the improvement in techniques of observation and measurement of the various structural features of the quasars that has been accomplished during the past few years there is now ample evidence to substantiate the qualitative account of the structural pattern given in the foregoing paragraphs. Enough measurements are also available to enable reaching some conclusions with respect to the most significant of the items that can be evaluated quantitatively: the magnitude of the separation between the two principal radio components.

When a star or particle in the interior of a quasar, which is moving in equivalent space by reason of its participation in the motion of the quasar as a whole, acquires an individual speed in excess of that of light it crosses a second unit boundary, and again an inversion of physical properties takes place. This second inversion brings the motion back into actual space, and the third of the components that make up the total scalar motion of the ultra-high speed aggregates in the quasar therefore has the same general characteristics as the normal recession. It is, however, subject to limitations because of its position as the *third* unit. Only a relatively minor part of its total magnitude is effective in the region below unit speed, and the spatial displacement that it causes is correspondingly small. (Like the 8-x space-time equivalence previously discussed, this inter-regional asymmetry is a principle of wide applicability. For example, it enters into the determination of such physical quantities as the coefficient of thermal expansion and the inter-atomic distance, the study of which led to the original formulation of the Reciprocal System of theory.)

The explanation of the asymmetry lies in the fact that motion in time and motion in space are coincident only at the unit level. This is essentially no more than a point contact, and motion in one region can be transmitted to the other only through the medium of those units of motion that are specifically directed toward the point of contact. As brought out in previous publications, one out of every eight units of a linear motion in space is effective in the adjoining time unit (or vice versa). A reduction of this magnitude thus takes place between the third unit of speed (a spatial unit) and the second unit (a temporal unit). Here a still greater reduction is effective, as there is no requirement that the motion transmitted from unit three be restricted to the dimension in which it will be in contact with unit one, the spatial region below the speed of light. In the absence of such a restriction, the motion is distributed over all three dimensions of the time unit (unit two), and only one unit out of every 83 is passed on to unit one.

One third of the latter amount is visible in each of the three dimensions of the low speed region, and we therefore arrive at the conclusion that where the normal speed of recession is z , the two radio components of a quasar (the ultra-high speed components) are separated by a distance $z/(3 \times 84) = 8.4 \times 10^{-5} z$. The natural unit is equal to radians at $z = 1.00$, and in terms of seconds of arc, the conventional unit in which the measured separations are expressed, this becomes 16.8 z . Inasmuch as the *observed* length of any separation is inversely proportional to the distance z , the foregoing result tells us that the observed separation between the two radio components should be constant for all quasars of early or medium age (those which have not yet reached the stage where secondary explosions are taking place on a large scale) and should be 16.8 seconds of arc. The separations measured by D. E. Hogg (*Astrophysical Journal*, Mar. 1969), together with the deviations from the theoretical separation (excluding those measurements that could

not be clearly identified with quasars, and two other values that will be considered later) are shown in the following tabulation:

COMPONENT SEPARATIONS					
Quasar	Separation	Deviation	Quasar	Separation	Deviation
3C 273	19.6	+2.8	3C 288.1	6.4	-10.4
3C 249.1	18.8	+2.0	3C 208	10.5	-6.3
3C 275.1	13.2	-3.6	3C 204	31.4	+14.6
3C 261	10.8	-6.0	3C 181	6.0	-10.8
MSH 13-011	7.8	-9.0	3C 268.4	9.4	-7.4
3C 207	6.7	-10.1	3C 280.1	19.0	+2.2
3C 336	21.7	+4.9	3C 432	12.9	-3.9
3C 205	15.8	-1.0			

In view of the many uncertainties that are involved, this is probably as close a correlation as we can expect at this stage of the investigation of the subject. The average deviation is 6.3. The observers' estimates of the probable error range from 0.5 to 2.4, but such estimates do not usually take fully into account 811 of the uncertainties that are inherent in the methods and the assumptions that are utilized. The results obtained by Kapahi, *et al* (*Astronomical Journal*, Oct. 1973) are similar to those of Hogg, and it is interesting to note that 5 of their 15 measurements fall in the range from 15 to 17, practically on the theoretical target.

The average deviation of the values reported by Macdonald and Miley is considerably larger, but these authors comment that their list includes many objects in which the radio components are so far distant from the optical that, in their words, "If the radio structures of the larger QSOs were not symmetric about the optical QSO they might not have been identified." This suggests that the quasars with the larger component separations represent a different group of objects, the members of which are farther along the evolutionary path, and have undergone some further explosive activities that have given portions of the quasar motions away from the main body. Such a hypothesis is supported by a further comment from the investigators which seems to indicate that, in some instances, both types of component separations are present in the same quasars. "Many sources", they say, "have large scale structure but small scale components dominate." The observed values of the separations are also in agreement with this explanation, as the separations of almost all of those that deviate from 16.8 by any large amount (including the two excluded from the tabulation of the results reported by Hogg) are inversely proportional to the distance, as they theoretically should be if they are the results of secondary explosions of comparable size.

Since the frequency of these secondary explosions (those that occur within the quasar after the original ejection) increases with age, a point is ultimately reached where practically all of the constituent stars and particles have acquired ultra-high speeds by reason of the large amount of energy released. It then follows that because the lateral

displacement of the radio components is due to the existence of two distinct populations of stars and particles with very different average speeds, when the low speed component is eliminated the lateral displacement effect terminates. The very old Class II quasars therefore show no spatial extension other than that corresponding to the spatial dimensions of the central objects, and as these are very small they are mainly beyond the resolving power of existing facilities. The list of “unresolved” objects included in the Macdonald and Miley report is, as would be expected from the foregoing, made up principally of Class II quasars that, on the basis of criteria such as the presence of absorption redshifts, large radio emission, and high z values, are in an advanced stage of development.

In this matter of the separation of the radio components of the quasars we again encounter a situation in which the observations definitely *demand* something that conventional theory cannot supply. As expressed by Kellerman (*Astronomical Journal*, Sept. 1972), “*either*: The linear dimensions of radio sources depend on red shift in must such a way as to cancel the geometrical effects of the red shift, or: The geometric effect of the red shift on apparent size is negligibly small.” Neither of these alternatives can be accommodated within the boundaries of conventional physical theory, and therefore, Kellerman says, astronomy is confronted with a paradox.

But, in fact, this is not a paradox. It is simply a message from nature, and it is the same message that we get from the analysis of the redshifts in Arp’s associations. It tells us that inasmuch as the lateral displacements, like the excess redshift, are *directly related* to the recession, and are therefore observable effects of *motion*, the conventional narrow view of motion, which limits it to speeds less than that of light and to effects that can be represented within a three-dimensional spatial system of reference, must be broadened. When we look at this situation in the context of a universe of motion, where we do have the benefit of a broader perspective, there is no paradox. The theoretical separation that exists in such a universe is exactly what Kellerman says the observations show; that is, “the linear dimensions of the radio sources” (the quasars) *do* “depend on red shift in must such a way as to cancel the geometrical effects of the red shift.”

The theoretical explanation of the total motion pattern of the quasars may now be summarized as follows: The recession of the galaxies (including the galactic fragments known as quasars) is due to the outward scalar motion at unit speed that applies to all objects at rest in the natural reference system. The excess redshift of the quasars is an observable effect of a second unit of speed imparted to the ejected fragment by the galactic explosion. The lateral displacement of the regions of radio emission within the early type quasars is an observable effect of a third unit of speed that has been acquired by one of the two distinct populations of stars and particles that are present in these quasars. From the *natural* standpoint, there is merely one motion at a speed of three units (three times the speed of light), but because of the limitations of the system of reference to which this motion is customarily related, each of the three units of speed appears to have effects different from those of the others. The motion as a whole is reduced, for a finite period of time, by gravitation, and each of the three units undergoes a proportionate reduction. Consequently, there are definite mathematical relations between the recession and the observed effects of the other two units of speed. Here, again, the new theoretical

development gives us a picture of the situation that is in full agreement with the observations, however paradoxical the observational results may seem in the light of orthodox theory.

There are many pitfalls in the way of anyone who attempts to carry out a long chain of reasoning from broad general principles to specific details, and as this is an initial effort at applying the Reciprocal System of theory to the internal structural features of the quasars, it must be conceded that modification of some of the conclusions that have been reached is likely to be necessary as observational knowledge continues to accumulate. However, the general picture of the quasar structure derived from theory corresponds so closely with the information now at hand that there seems little reason to doubt its validity, particularly since that picture was developed easily and naturally from the same premises on which the conclusions reached in *Quasars and Pulsars* regarding the origin, nature, and behavior pattern of the quasars were based.

It is especially significant that nothing *new* is required to explain either the existence or the properties of the quasars. Of course, nothing new can be *put into* a purely deductive theory of this kind. Introduction of additional hypotheses or *ad hoc* assumptions of the sort normally employed in the adjustment of theories to fit new observations is excluded by the basic design of the theoretical system, which calls for deriving all conclusions from a single set of premises, and from these only. But some new principles and hitherto unknown phenomena are certain to be revealed by any new theoretical development of this magnitude, and many such discoveries have, in fact, been made in the course of the theoretical studies thus far undertaken. Such items as those utilized in the foregoing application of the theory to the various aspects of the quasar situation—the status of all physical phenomena as more or less complex relations between space and time, the inversion of these relations at unit levels, the role of time as equivalent space, and the asymmetric transmission of physical effects across unit boundaries—are all new to science. But these are not peculiar to the quasars; they are *general* principles, immediate and direct consequences of the basic postulates, the kind of features that distinguish a universe of motion from the conventional universe of matter, and they were discovered and employed in a variety of applications decades before the quasar study was undertaken. Not even a single new theoretical idea was required either for the original development reported in *Quasars and Pulsars* or for the extension of that development in these pages. *All* of the novel principles deduced from theory and utilized in this work were explicitly set forth in the initial presentation of the Reciprocal System of theory in *The Structure of the Physical Universe*, published in 1959, years before the quasars were even discovered.

Furthermore, the consequences of those general principles in the form of physical phenomena and relations that are now seen to play an important part in explaining the origin and evolution of the quasars were likewise pointed out in detail in that 1959 publication, four years before Maarten Schmidt measured the redshift that ushered in the era of the quasar “mystery.” The status of stellar aggregates as structures in positional equilibrium, which permits the building up of internal pressures in the galaxies, and the ejection of fragments; the existence of two distinct divisions of the explosion products, ejected in opposite directions, one moving at normal speed and the other moving at a

speed in excess of that of light; the reduction in the apparent spatial size of the aggregates that move at ultra-high speeds; the generation of large amounts of radiation at radio wavelengths from the explosion products; and the eventual disappearance of the high speed material; were all derived from theory and described in the published work, not only long before the discovery of the quasars, but years before any definite evidence of the galactic explosions that produce the quasars was found.

The theoretical development prior to 1959 was not carried far enough to predict the existence of the quasars, but it is certainly correct to say that it predicted the existence of the *class of objects* to which the quasars, on the basis of present knowledge, belong; that is, the ultra-high speed products of galactic explosions. The accuracy with which the Reciprocal System of theory was able to describe phenomena that *had not yet been discovered* is a significant demonstration of the power and versatility of this new theoretical system based on the concept of a universe of motion, and it should provide ample justification for whatever effort is required in order to understand the basic elements of the theory and their application to the subjects under consideration.

In addition to the new information specifically applying to the quasars that has been accumulated during the past three years, some new facts about related objects have also been ascertained, and here, too, the additional information is consistent with the theory. None of these items is conclusive in itself, but as a whole they add considerable weight to the assertion that the theory provides a correct representation not only of the quasars but also of the related phenomena. Perhaps the most important contribution made by the additional information is that it leaves little room for doubt that these phenomena are, in fact, related to the quasars, and it thereby calls for an explanation of the nature of that relation, a need that has been met in *Quasars and Pulsars*.

As noted in that work, theoretical considerations indicate that a large proportion of the quasars should appear almost directly in front of the galaxy of origin or almost directly behind it. When the quasar is behind the galaxy its radiation is absorbed and re-radiated, so that what we should observe is a galaxy with a very prominent nucleus. The distinguishing feature of the N-type galaxies is a nucleus of this kind, and it was tentatively concluded in the previous publication that this class of observed objects could be identified with the galaxies that are theoretically occluding the quasars. This finding has now been strengthened by observations indicating that “the spectra and colors of quasars are similar to those of the nuclei of N galaxies” (*Science*, Sept. 21, 1973).

A substantial number of cases here been found in which a quasar appears to be superimposed on an ordinary galaxy, and this has led to a suggestion that *all* quasars, may simply be N-galaxies with very prominent nuclei. As can readily be seen, however, the theory that requires some quasars to be behind the galaxy of origin, giving rise to N-galaxies, also requires others to be in front of the galaxy of origin. While most such quasars will overpower the radiation from the galaxies and will appear to be alone, it is obviously possible that in some instances evidence of the existence of the accompanying galaxy may be observable, particularly at the shorter distances. In this connection it should be noted that one observer, Jerome Kristian, mentioned that some of the quasars of this class that he studied were “off center” with respect to the underlying galaxies. This is rather difficult to explain on the basis of the N-galaxy hypothesis, but it is, of course,

easily understood if what is being observed is a quasar *almost* directly in front of the galaxy of origin.

Another observation that has been interpreted as evidence in favor of the N-galaxy hypothesis is a change of three magnitudes in the emission from the galaxy X Comae, which leads the observers (Bond and Sargent, *Astrophysical Journal Letters*, Nov. 1, 1973) to conclude that this is “an object that apparently can change temporarily from an N-type galaxy to a QSO.” This, they say, “clearly supports the hypothesis that quasars are simply very bright galactic nuclei.” However, the explanation provided by the theory presented in this work is not only equally consistent with the observations, but also explains how and why the change takes place, something that is conspicuously lacking in the N-galaxy hypothesis. If the quasar is behind the galaxy from which it was ejected, it is quite possible for changes to occur, as that galaxy rotates, in the amount of matter through which the quasar radiation must pass. Such changes are probably no more than minor in the usual case, but they obviously *can* extend all the way from a condition in which the entire quasar radiation is absorbed and re-radiated, so that we see an N-galaxy, to a condition in which that radiation passes through essentially unchanged, and we see a quasar.

A large amount of attention has been centered on the Seyfert galaxies, and it is now generally agreed that there is sufficient evidence to show that these are “periodic explosions in the Seyfert nucleus that blast debris into the surrounding regions” (1973 *Yearbook of Astronomy*). But “all models of Seyfert nuclei ultimately rely on the *ad hoc* existence of a primary energy source”, and “conventional concepts of nuclear physics are woefully inadequate in accounting for such a large energy output from such a minuscule region” (*Ibid.*). The theory developed in *Quasars and Pulsars* explains where the energy comes from, why it emanates from a region of such small spatial dimensions, and why these Seyfert explosions do not produce quasars. All of the new evidence is in agreement with this explanation.

The additional confirmation of the existence of high speed gas motions in the cores of the Seyfert galaxies, and of “periodic explosions” in these objects, intensifies the problem that conventional physical and astronomical theory faces in attempting to account for the build-up and containment of the very energetic material in the interior of a galaxy until the time of the explosion. As R. J. Weymann pointed out in a statement quoted in *Quasars and Pulsars*, conventional theory has no way of explaining this containment. This, then, is another of the places where the Reciprocal System of theory, by providing an explanation, is simply filling a conceptual vacuum.

Like the items which confirm the existence of a build-up of energy, and of periodic explosions, in the Seyfert galaxies, some other recent observations have also given added support to the feature of the theory which says that all of the very energetic events that are taking place in galactic nuclei, all the way from the relatively mild activity in galaxies such as our own, through the intermediate Seyfert type, to the tremendous explosions in the giant elliptical galaxies that produce the quasars, have the same origin and the same general nature, differing only in magnitude. It has been shown by Fath, *et al.* (*Astronomy and Astrophysics*, April (I) 1973) that the amount of radio emission (which is an indication of the extent of the explosive activity) is related to the brightness, and hence to

the size, of both spiral and elliptical galaxies, as the theory requires. Also “the underlying galaxy (of the N-system) has the same colors as a giant elliptical (E) galaxy” (*Science*, Sept. 21, 1973), an observation that tends to support the theoretical finding that this “underlying galaxy” is a giant elliptical that exploded and ejected a quasar.

In early 1971, after *Quasars and Pulsars* had gone to press, a flurry of excitement was generated by a report from a group of investigators at MIT which appeared to indicate that speeds somewhere in the neighborhood of three to ten times that of light had been observed in a quasar. Typical of the reaction was a caption in the *New Scientist* which read “Enigmatic Redshifts Cause Cosmic Chaos.” The initial impact of this discovery has been softened by the passage of time, but there is still no satisfactory explanation of the observations on an orthodox basis. Indeed, as long as the validity of the observational results remains unchallenged, these observations constitute a powerful argument against the cornerstone of the orthodox position, the cosmological redshift hypothesis. Spatial speeds greater than that of light are equally as impossible in the context of the Reciprocal System of theory as in conventional physics (the ultrahigh speeds involve motion in time rather than in space) but no problem arises when the observations are interpreted in the light of this new system, as the substitution of the “intermediate” for the “cosmological” explanation of the redshifts reduces the indicated speed to an acceptable value.

This concludes the discussion of those of the new items of information which, as matters now stand, appear to have a bearing on the question to which this review is addressed: the question as to the accuracy of the conclusions reached in *Quasars and Pulsars*. The facts brought out in the preceding pages make it evident that the theoretical explanation of the quasars derived from the Reciprocal System of theory is in full accord with all of the information that has been gathered during the past three years. Even those conclusions that were specifically designated as “tentative” in the original discussion still stand. This is a graphic illustration of the great advantage of having a purely deductive theoretical structure that contains no empirical elements, and is therefore capable of arriving at the correct answers not only in the familiar regions of the universe, where factual information is plentiful and accurate, but also in relatively new areas where the available observational data are meager and not wholly reliable.

In striking contrast, conventional physical theory has been faced with one serious problem after another where attempts have been made to apply it to the new astronomical areas, and recognition of its inability to deal with the quasars and some of the other classes of recently discovered objects has been growing rapidly during the past few years. One of the first to voice his dissatisfaction publicly was Fred Hoyle. In the George Darwin lecture given to the Royal Astronomical Society in 1968, Hoyle sounded a clear call for a “radical revision of the laws of physics.” As reported in the *New Scientist* of Oct. 17, 1968,

Professor Fred Hoyle was convincing about the total inadequacy of conventional physics to account for the behavior of many of the recently discovered objects in the universe.

Three years later, in an article in *Nature*, Sept. 3, 1971, Hoyle, together with J. V. Narlikar, returned to the attack, and stressed the need, not only for a change, but for a *major* change.

We wish to emphasize the need for a thoroughly radical assessment of the (redshift) problem, considering it unlikely that a satisfactory theory will be achieved by a small change in our concepts.

Here are some of the more recent comments by other observers:

Clearly, the physics of radio galaxies and quasars, the nature of the red shift, and perhaps fundamental physics itself are being questioned by these measurements (recent radio observations). (K. I. Kellerman, *Physics Today*, Oct. 1973)

But physically we know the least about these peculiar objects (quasars, etc.) and they are the ones for which there is the greatest a priori chance that new and unknown physical mechanisms are at work. (Halton Arp, *Science*, Dec. 17, 1971)

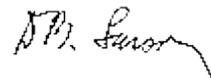
Physics and Astronomy: Unexpected Results May Require New Concepts. (Caption of article in *Science*, Dec. 28, 1973)

It is believed by some that the final solution (to the energy problem in the quasars) will only come after astronomers have rewritten some of the laws of physics. (Simon Mitton, *Astronomy and Space*, Vol. 1)

In these statements some of the prominent figures in the astronomical world are asserting that the present situation in astronomy requires a drastic modification of basic physics; not merely “a small change in our concepts” but something “radical” that will introduce hitherto “unknown physical mechanisms” that are capable of accounting for the phenomena that cannot be explained by conventional theory. Now a new system of theory that meets those specifications has made its appearance. This theory makes only *one* basic change—it changes the prevailing concept of the general nature of the physical universe—but the necessary consequences of this one change introduce the new physical mechanisms that are essential for an understanding of the quasars and other “mysteries” both in astronomy and in physics.” In other words, this new theory is just what Hoyle, *et al*, have been asking for, both in its general nature and in its results. In fact, the results actually go a big step beyond the astronomers’ demands, as this new development gives them (and the physicists as well) a purely deductive theory, one in which all conclusions in all fields of physical science are derived from a single set of basic premises.

Of course, this theory upsets some cherished physical and astronomical ideas and beliefs, but obviously this is part of the price that must be paid for *any* revision of basic concepts that is drastic enough to produce the required results (if being forced to abandon erroneous ideas can legitimately be classed as a price).

D. B. Larson



March 1974

QUASARS - HOW BIG ARE THEY?

To recipients of the review article QUASARS-THREE YEARS LATER:

In the original draft of the above mentioned article the author included a supplement containing a detailed account of an analysis of the quasar luminosity data which he has carried out for the purpose of determining the range of sizes of the fast-moving galactic fragments that he has identified as the quasars. Inasmuch as the article, even without this supplement, was considerably longer than we had anticipated, we did not consider it feasible to add this much to the material intended for general distribution. It is, however, a significant extension of the previous theoretical work, and we have therefore reproduced it separately. We are sending copies to those of the recipients of the original article who we believe are particularly concerned with the subject matter.

In connection with your examination of this material you may be interested in an article by Dr. Allen D. Allen that is now receiving considerable attention. This article originally appeared in *Foundations of Physics*, Dec. 1973, and was rewritten for publication in the *Intellectual Digest*, June 1974. Dr. Allen points out that the conventional view which regards the universe as being composed of “elementary particles” of matter is encountering extreme difficulties, and that, as a consequence, an increasing amount of support is being given to “the concept that ultimately the world is constructed from principles rather than from units of matter”. This is the kind of a theory on which the quasar analysis is based, as the fundamental entity in Larson’s Reciprocal System of physical theory is not matter but the specific mathematical relation (or “principle”) that he has identified as motion. Some of the conclusions that are reached with respect to the quasars no doubt seem strange, perhaps almost incredible, in the light of opinions and beliefs derived from orthodox thought, and it should therefore be helpful to know that these unconventional conclusions are not only fully in accord with the observed facts, as the results of this and previous studies show them to be, but are also products of a theory that is now, in Dr. Allen’s words, “an established (if competing) theory in the mainstream of theoretical physics.”

—North Pacific Publishers

Gravitation and the Galaxies

Today, three centuries after Newton, gravitation is still one of the enigmas of science. “It may well be the most fundamental and least understood of the interactions,” says Robert H. Dicke. In all of the efforts that have been made to formulate a unified physical theory the big challenge has always been to bring gravitation within the theoretical framework. One of the most basic problems is to define the nature of the phenomenon. According to Einstein’s general theory of relativity, the theory that is currently accepted (often with some reservations), gravitation is equivalent to a motion. This assertion implies that, while it has some of the characteristics of motion, it is actually *not* a motion. The objective of the present discussion is to examine the validity of this conclusion.

Let us consider a dispersed system of gravitating objects isolated in space. From our present knowledge of the gravitational effects, we can deduce that each of these objects will move toward all of the others. In this particular case, then, gravitation *is* a motion, not merely the equivalent of a motion. It is a motion that differs in some respects from the motions with which we are familiar, but it is by no means unique. The motions of the galaxies, for example, have the same characteristics, except that these objects are moving outward away from each other, rather than inward toward each other. All of the distant galaxies are observed to be receding from our Milky Way galaxy at high speeds. Unless we make the assumption that our galaxy is the only stationary object in the universe, an assumption that was repudiated by science long ago, our galaxy is likewise receding from all others. Thus the galactic system is one in which all individuals are moving outward away from each other.

A small scale example of the same kind of motion can be seen in the motion of spots on the surface of an expanding balloon, often used as an analogy by those who undertake to explain the nature of the motions of the galaxies. Here, too, each individual is moving outward from all others. If the expansion is terminated, and succeeded by a contraction, the motions are reversed, and each spot then moves inward toward all others, as in the gravitational motion.

In each of the examples cited, the inward or outward motion of the individual points or objects takes place in all directions, which means that the motions have no specific, or inherent, directions. It follows that these are *scalar* motions, defined by magnitude and sign (positive or negative, represented as outward or inward in the reference system). Here, then, we observe three different examples of a type of motion, *the existence of which is not recognized by present-day physical science*.

This lack of recognition is due to the fact that in current practice motion is defined in a manner which excludes scalar motion. The prevailing view is that motion is a change of position relative to some identifiable point or object, and it is assumed that this change can be represented in a coordinate reference system. On this basis, the magnitude and direction of the change are specified by a vector, which occupies a definite position in the reference system. But it is evident that a system of scalar motions cannot be represented in its true character in this spatial reference system, as the system of coordinates has no way of representing simultaneous motion in all directions. In order to make

representation possible, the scalar system must be coupled to the reference system at some particular point, the *reference point*, as we will call it. This point, or the object at that location, is then seen as stationary, or moving vectorially independently of the scalar motion, while all other points are moving inward toward, or outward away from, the reference point.

In the case of the galaxies, we take our galaxy as the reference object, and view all of the distant galaxies as moving radially outward from our location. But it can easily be seen that the directions thus imputed to the galactic motions are determined by the coupling to the reference system, and are not inherent in the motions themselves. For example, if we denote our galaxy as A, the direction of motion of galaxy X, as we see it, is AX. But observers in galaxy B see it moving in the very different direction BX, those in galaxy C see the direction as CX, and so on.

In this particular case, the reference point is the location of the observer, because we assume that we are stationary in the spatial reference system that we are using. But in the more general situation, the observer is outside the scalar system of motions, and the reference point is determined by whatever influence dictates the coupling to the reference system. The expanding balloon, for instance, may be resting on the floor of a room, in which case the point that touches the floor is motionless in the reference system, and is therefore the reference point for the scalar motion.

Before this balloon was placed in the reference system, points A and B on the balloon surface were moving outward away from each other, and their separation was increasing at a specific rate. Immobilization of point A, the reference point, in the reference system did not change the rate of increase in the separation between A and B. But the reference system now shows point A as motionless. In order to maintain the correct rate of separation between A and B, it is now necessary for the reference system to attribute the motion of point A to point B, giving that point an additional motion component, over and above its own motion. It can easily be seen that this is a general property of the representation of scalar motion in a spatial reference system. The scalar motion of the reference point or object has to be attributed to the points or objects with which it is (apparently) interacting.

With the benefit of this understanding of the relation between scalar motion and the reference system, we can return to the gravitational problem, and consider the situation in which the gravitating object is *not* free to move in the reference system. Here, the present-day physical science is faced with a contradiction. The behavior of gravitating objects that are free to move shows that gravitation is a motion. But there are gravitating objects that do not change their positions in the reference system, and therefore are not in motion, as motion is currently defined. The reaction of the theorists to the situation has been to evade the issue by treating gravitation as a *force* rather than as a motion.

At this time, therefore, we need to give some consideration to the relation between force and motion. For application in physics, force is defined by Newton's second law of motion. It is the product of mass and acceleration: $F = ma$. Motion is measured on an individual mass basis as velocity, or speed (that is, *each* unit moves at this rate), or on a collective basis as momentum, the product of mass and velocity, or speed. Momentum

was formerly called “quantity of motion,” a term that more clearly expresses the true nature of the quantity. The time rate of change of motion is dv/dt (acceleration, a) in the case of the individual units, and $m dv/dt$ (force, ma) when measured collectively. Thus force is a property of a motion, in exactly the same way as acceleration. It is the time rate of change of the total quantity of motion, the “quantity of acceleration,” we could call it.

It follows from this that a force cannot be autonomous. Every force is, *by definition*, a property of a motion. Thus a force cannot originate in a motionless object. The problem of the motionless gravitating objects is therefore not solved by the introduction of the force concept. What is needed is a recognition that gravitation is a scalar motion, and that the apparently motionless gravitating object is actually moving inward in all directions just as it is when it is moving in free space. But, like the spot on the balloon surface that is resting on the floor, and like our Milky Way galaxy, it is coupled to the reference system in the location which it occupies, and it is therefore stationary *in the context of that reference system*.

The effect of a negative (inward) scalar motion is to decrease the separation between the individual members of the scalar system. Inasmuch as the reference object is actually in motion, even though it is represented in the reference system as motionless, the gravitational motion of this object contributes to the magnitude of the decrease in separation between it and any distant object. And since the reference system cannot attribute this contribution to the object that is represented as motionless, it has to attribute the entire decrease in separation to motion of the distant object. In the gravitating systems with which we are most familiar, one member of each system (the earth, for example) is much more massive than the objects with which it is interacting and becomes the reference object because it is immobilized by its own inertia. The contribution of this reference object to the motion of the other objects of the gravitating system (falling bodies) is clearly evident, and the reference object is therefore credited with exerting a force of attraction on each of these other objects. When it is recognized that gravitation is a scalar motion, it can be seen that the motion component, or force, apparently acting against the distant object is actually the motion of the reference object itself, misrepresented by the reference system, which is incapable of representing scalar motion correctly.

The transfer of the motion of the reference object to the objects with which it is interacting explains the presence of a “force field” in the space surrounding the reference object. This field is not a tangible physical reality. Nor is it a strain in the hypothetical ether, or in space, as asserted in some theories. In fact, if there is no other mass within the effective gravitational range of the reference object, the force field does not correspond to anything at all, other than potentially. But if a mass is introduced into this region, a portion of the gravitational motion of the reference object is transferred to this mass by the manner in which the scalar motions are represented in the reference system. Since the reference object is moving in all directions, the force field due to its motion is radial, and there is no need for the kind of a distortion of space that Einstein’s general theory calls for.

When gravitation is recognized as a scalar motion it becomes evident that the forces due to electric charges and the corresponding magnetostatic phenomena (magnetic charges,

we may call them) are likewise properties of scalar motions. Observationally, these forces differ from the gravitational forces only in those respects in which scalar motions are variable; that is, in magnitude and in sign. Here, again, the absence of observable motion at the points of origin is due to the fact that the locations of the motions (the locations of the charges) are the reference points at which the motion is frozen by the coupling of the moving scalar system to the reference system.

This explanation of the origin of the forces that appear to be exerted on the distant objects provides the answer to the long-standing problem of action at a distance. Newton's gravitational law appears to call for direct action of one mass on another, regardless of their spatial separation, but many scientists are strongly opposed to the idea that a force can be exerted without a physical contact of some kind. The prevailing opinion has therefore been that the force *must be* transmitted through some kind of medium, even though there is no actual evidence to support this assumption. The first hypothesis called for transmission through a medium, the ether, which was assumed to exist in space, but this hypothesis encountered difficulties because of the contradictory properties that the ether would have to possess in order to meet the requirements. It has therefore been succeeded by the concept of space itself as the medium, with various kinds of fields located in this space. The need for speculative constructions of this kind is now eliminated by the finding that the apparent action at a distance is merely an illusion due to the inability of the spatial reference system to represent scalar motion as it actually exists. In reality each object in a scalar system is pursuing its own course, independently of the other objects in that system.

The foregoing discussion of the scalar motion situation should be sufficient to demonstrate that by failing to give consideration to the scalar form of motion modern science has made a serious error. It is no doubt difficult for most scientists to believe that there could be a major defect in the *foundations* of present-day physical theory, but the facts are clear. The existence of scalar motion is incontestable. As pointed out earlier, it is readily observable in several different phenomena. The properties of this kind of motion can easily be deduced. Knowledge of these properties then enables identifying additional phenomena, including some of the most fundamental features of physical activity, as motions of the scalar type. The need for a thorough reconsideration of basic physical theory to take the various manifestations of scalar motion into account is therefore clearly indicated.

SUPERNOVA 1987 A

I have received a number of inquiries as to how well the observations of the supernova that has been observed in the Large Magellanic Cloud agree with the theoretical conclusions about supernovae in general that are expressed in *The Universe of Motion*. I cannot give a definite answer to this question as yet, since the observational data thus far reported are limited, and to some extent conflicting. However, I can give what may be considered a progress report, based on the situation as it stands in the light of the information that has appeared thus far in the publications accessible to the general public. none'.

The Theories none The astronomers' theory of supernovae assumes that the generation of energy in the stars takes place by conversion of hydrogen to successively heavier elements, eventually resulting in an exhaustion of the hydrogen supply, and a consequent collapse of the stellar structure. The smaller stars are assumed to collapse quietly into white dwarfs, but the collapse of the larger stars (those more than about 8 times the mass of the sun) is assumed to be of such a catastrophic nature that it leads to an explosion. none. Our theory assert that the supernova explosion occurs when a star reaches one of two limits, a *mass* limit (Type I) or a limit related to *age* (Type II). none'.

Size of Exploding Star. none'The first reports of the LMC supernova indicated that the star which exploded had been identified, and was a large one. Later observations showed that this star was still intact, and no other large star at this location could be found on the pre-explosion photographs. This probably means that the explosion occurred in a small star, contradicting accepted theory. none. Our findings are that *any* star can become a supernova. at the appropriate stage of its development. none'.

Intensity of Explosion none. The maximum observed brightness is reported to be "faint for a supernova", and the supernova is developing much faster than expected. These observations agree with the conclusion that the exploding star was a small one. none'.

Supernova Type none'It is now generally conceded that the explosion is Type II. none'Our finding is that Type II is the *only* kind of an explosion that a small star can undergo. none'>Chemical Composition of Products none. According to the astronomers' theory of the supernova, the amount of hydrogen in the explosion products should be very small. none'On the basis of our theory, the constituents of the star should be predominantly hydrogen. none'So far, all that has been observed is "an envelope of luminous hydrogen" none.

Neutrinos none' There is much excitement about the reported observation of bursts of neutrinos that apparently originate from the supernova. But the production of some neutrinos in high energy processes is a feature of all present-day theories, while no theory is firmly enough established quantitatively to yield unequivocal conclusions. The neutrino observations therefore cannot be expected to contribute significantly to a resolution of the question as to the validity of conflicting supernova theories. none.Our theoretical development has not yet been extended to the neutrino production in high energy processes. none'.

Astronomers' Reaction none. As matters now stand, the astronomers are conceding that the supernova is not behaving according to their theoretical expectations. A report in the March 13 issue of "Science News" contains the following statements: none' One thing that seemed clear at the March 6 meeting is that the theorists are having a hard time assimilating the information from this, the nearest supernova since 1604. none. It's hard to make something dim into a type II. (Comment on indications that the original star was dim, and that the supernova is type II.) none. The first radio observations caused more theoretical consternation. none' In contrast to these comments on the theoretical problems that the astronomers are facing, we can say that all observations thus far are entirely consistent with the supernova theory set forth in *The Universe of Motion*. none.

D. B. Larson

The Density Gradient in White Dwarf Stars

In connection with assembling the material for a new edition of the 1959 book in which I introduced the theory of a universe composed entirely of motion, I am reviewing the progress that has been made in the intervening 22 years, both in the development of the details of the theory itself and in the fields of observation and experiment, to make certain that the new work has the benefit of these advances. One item that came to my attention during this review is particularly important because it supplies a positive verification of the theoretical findings as to the structure and density of the white dwarf stars, a result that has far-reaching implications.

In order to appreciate the significance of the observed facts in relation to the theory, it is necessary to understand the general nature of the motion of which the theoretical universe of motion is composed. The most important direct consequence of the postulates that define this universe is the existence of a general reciprocal relation of a scalar nature between space and time. By reason of this reciprocal relationship, motion in such a universe can take place either on the basis of a space-time ratio of $1/n$, a speed less than unity (which we can identify as the speed of light), in which case the change of position takes place in space, or on the basis of a space-time ratio of $n/1$, a speed greater than unity, in which case the change of position takes place in time. The first of these alternatives is the prevailing motion in our immediate environment. What I have shown in my previous publications is that the extremely compact astronomical objects discovered in recent years--white dwarf stars, pulsars, quasars, etc.--are aggregates whose components are moving at greater-than-unit speeds.

Of course, the idea of speeds in excess of the speed of light conflicts with Einstein's dictum that such speeds are impossible, but to err is human, and Einstein is no exception. As usually happens in such cases, the error stems from the use of an invalid assumption. In his book, *The Character of Physical Law*, Richard Feynman points out that when we put all of our presumed knowledge together, "we get inconsistency, because we get infinity for various things when we calculate them, and if we get infinity how can we ever say that this agrees with nature?" Feynman attributes this inconsistency to the use of "a number of tacit assumptions... about which we are too prejudiced to understand the real significance." What Einstein apparently did not realize is that one of the assumptions on which he based his conclusions violates a universal law: the Law of Diminishing Returns.

Strangely enough, this law, generally recognized in most other fields of thought, is practically ignored in science. But we cannot repeal a law of nature by ignoring it. This is the law that prohibits the infinities that Feynman deplures. It tells us that the ratio of the **output** of any physical process (such as the acceleration of a mass) to the **input** (in this case, the applied force) does not remain constant indefinitely, but eventually decreases, and ultimately reaches zero.

So the relation expressed in Newton's Second Law of Motion, $F=ma$, **cannot** remain constant. Recognition of this fact leads to an interpretation of the experimental results that is quite different from Einstein's. Instead of his conclusion that it is impossible to exceed the speed of light (which follows if, as he assumed, the relation $F=ma$ remains

constant), the correct interpretation is that it is impossible to accelerate a mass to a speed greater than that of light **by means of an electrical force**. In other words, the limitation is not on the speed, but on the capabilities of the process. The significance of this is that it does not preclude acceleration to higher speeds by other means, such as the sudden release of large quantities of energy in violent explosions.

One of the reasons why Einstein's interpretation of the observed facts has been so widely accepted in spite of its unsound foundation, involves another of the "tacit assumptions" mentioned by Feynman. It has been **assumed** that a speed in excess of that of light would result in a corresponding increase in the rate of change of spatial position. The absence of any observed changes of position at higher rates (except for some observations of quasar components, whose true significance is still in doubt) has therefore been regarded as a confirmation of Einstein's conclusion. But here again, the conclusion that has been drawn goes beyond the evidence, which applies only to the rate of change of position in space, and has relevance to the speed only insofar as the change of position due to the motion takes place in space. In the universe of motion, the change of position is in space if the space-time ratio (speed) is $1/n$. It is thus impossible for a change of position in space to take place at a rate (speed) in excess of unity (the speed of light), because the limiting value of the quantity $1/n$ is $1/1$. But this does not mean that higher speeds are impossible; it merely means that motion at higher speeds, with space-time ratio $n/1$, is motion in time rather than motion in space.

According to the theory of a universe of motion, the neutral condition is motion at unit speed, and the motions of the universe as a whole are symmetrical around this level, the true speed magnitude in each case being the deviation from unity. As a result of the space-time symmetry, the effect of any motion in time is the inverse of the effect of the corresponding motion in space. The particular motion with which we are concerned at the moment is the motion imparted to the products of the explosion of a star: a supernova. Some of the products of such an explosion are ejected at speeds less than that of light, and they take the form of a cloud of particles moving outward in space from the site of the explosion, but remaining in the original location (the moving location indicated by a clock) in time. Another portion of the explosion products is accelerated to speeds greater than that of light. These products take the form of a cloud of particles expanding into three-dimensional time, but remaining in the original location in space. This cloud of particles is the white dwarf star.

As I have shown in my publications, a development of the details of the properties and the evolutionary course of the white dwarfs on this theoretical basis leads to results that are in full accord with the observations. For present purposes, however, we are concerned only with the density relations. The expansion of the (relatively) slow-moving explosion products into space results in a large *decrease* in the density of the expanding aggregate. Because of the reciprocal relation between space and time, the expansion of the fast-moving product into time results in a large *increase* in the density of this aggregate. The white dwarf star is therefore an object of abnormally high density, compared to a normal star. Furthermore, the density gradient is the inverse of that which prevails in the normal stars; that is, the center of the white dwarf is the region of greatest compression in time (equivalent to expansion in space), and it is therefore the region of minimum density.

This picture of the white dwarf derived from the theory of a universe of motion is, of course, quite different from the currently popular view, and it is possible that many individuals will find it little short of outrageous. But the reason for writing this article is that in the course of my review of the progress in the white dwarf field that has taken place in recent years, it became evident that some of the information about these objects that is now available supplies a **positive confirmation** of the upside down nature of the white dwarf structure.

As pointed out by James Liebert in a review article in the 1980 *Annual Review of Astronomy and Astrophysics*, it is generally conceded that the apparently normal matter in the outside layers (atmosphere) of the white dwarf stars must have been accreted from the environment. (The development of the theory of a universe of motion arrives at this same conclusion.) This matter, then, is mainly a mixture of hydrogen and helium, with hydrogen as the major constituent. If conventional theory is correct, the heavier element, helium, will preferentially move downward, leaving the outer layers of the star enriched in hydrogen. On the other hand, if the inverse density gradient required by the theory of a universe of motion actually exists, the hydrogen will preferentially move downward, and the outer layers will be enriched in helium. The verdict from observation is unequivocally in favor of the universe of motion. Liebert reports that the "cooler helium-rich stars" are "the most numerous kind of white dwarf," and that some have almost pure helium atmospheres. "The existence of nearly pure helium atmosphere degenerates over a wide range of temperatures has long been a puzzle," he says. But it need not continue to be a puzzle. The helium accumulates in the outer layers because these are the regions of greatest density in the white dwarf.

This theoretical conclusion, strange as it may seem in the light of current thought, is further confirmed by an examination of the behavior of the elements heavier than helium, commonly lumped together as "metals" in discussions of stellar composition. The metals, too, should preferentially accumulate in the regions of greatest density: the center of the star, according to current astronomical theory; the outer layers, according to the theory of a universe of motion. Liebert describes the observed situation in this manner:

The metals in the accreted material should diffuse downward, while hydrogen should remain in the convection layer. Thus, the predicted metals-to-hydrogen ratio would be **at or below solar** (interstellar) values, yet real DF-DG-DK stars have calcium-to-hydrogen abundance ratios ranging from about solar to well above solar.

Here again, as in the helium distribution, the verdict is unequivocal. The larger concentration of the heavier elements in the outer regions definitely identifies these as the regions of greatest density, a result that is inexplicable on the basis of conventional theory, but is specifically required by the theory of a universe of motion. Liebert admits that no plausible explanation on the basis of current astronomical theory is known. The only suggestion that he mentions is that the accretion of hydrogen must be blocked by some kind of a mechanism, a far-fetched idea without the least support from observation.

When it is viewed in conjunction with the gradual decrease in component speeds that takes place as energy is lost to the environment, the inverse density relation also supplies an explanation of the occurrence of novae. The continued energy losses eventually result

in the speeds of some of the constituent particles dropping below the unit level, and into the region of motion in space. These particles then occupy more space because of their spatial speed, and they form "bubbles" that move to the region of least density, the center of the star. Accumulation of this material with high spatial speeds builds up a gas pressure. Eventually the pressure reaches a level at which it breaks through the overlying matter, resulting in a flare-up of the star, as the hot material from the interior is exposed briefly. The outburst relieves the internal pressure, the star resumes its normal condition, and a new pressure build-up begins.

The explanation of the origin, the extreme density, the novae, and other properties of the white dwarfs that I derived originally by deduction from the properties of space and time as they exist in a universe composed entirely of motion requires some significant conceptual reorientation, and most astronomers have been reluctant to entertain the possibility that current ideas may have to be altered to such an extent. However, more and more of those who examine the existing problems carefully are recognizing that **something** will have to undergo a drastic change, and are assessing the situation in a manner similar to the following from Martin Harwit:

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. (*Astrophysical Concepts*, Wiley, New York, 1973, page 9)

The big problem, of course, is to determine just *what* has to be changed, and what has to be put in its place. The inverse density gradient that we find in the white dwarfs now identifies one of the requirements that must be met by the "drastically revised" theory. It must provide a new explanation of the white dwarf structure that incorporates this upside down density relation. Perhaps there are alternative ways in which this requirement can be met, but it seems rather obvious that the first step in exploring the situation ought to be to take a good look at the theory already in existence that **anticipated** this requirement.

IS RELATIVITY CONCEPTUALLY VALID?

To the editor of *Reciprocity*:

I would like to call the attention of your readers to a series of letters in *Nature* initiated by a question raised by the prominent British scientist Herbert Dingle with respect to the special theory of relativity, and culminating in a communication from Professor Dingle published in the Aug. 31, 1973 issue of that journal.

As I have pointed out repeatedly in my publications, the theoretical development based on the postulates of the Reciprocal System arrives at the same mathematical results as special relativity, and therefore agrees that from a *mathematical* standpoint, special relativity is correct. But, as I have also pointed out, the current tendency to accept the *mathematical* validity of the theory as proof of its *conceptual* validity is completely unjustified. The serious consequence of this illogical reasoning is that it leads to a refusal on the part of most physicists to recognize the definite and positive evidence which shows that the special theory is not conceptually correct.

The issue raised by Professor Dingle concerns one such proof known as the “Clock Paradox”. It is generally conceded that if a theory claims to be valid within certain limits; it must apply to *all* situations within those limits, and consequently, a demonstration that the theory is *not* valid in some particular one of these situations invalidates the theory. The Clock Paradox involves defining a situation in which a straightforward application of the special theory results in an obvious absurdity. This shows conclusively that the theory is not conceptually valid, in spite of its irreproachable mathematical standing:

In the statement of this paradox, we assume that a clock B is accelerated relative to another identical clock A and that subsequently, after a period of time at a constant relative velocity, the acceleration is reversed and the clocks return to their original locations. According to the principles of special relativity clock B, the moving clock, has been running more slowly than clock A, the stationary clock, and hence the time interval registered by B is less than that registered by A. But the special theory also tells us that we cannot distinguish between, motion of clock B relative to clock A and motion of clock A relative to clock B. Thus it is equally correct to say that A is the moving clock and B is the stationary clock, in which case the time interval registered by clock A is less than that registered by clock B. Each clock therefore registers both more and less than the other.

As many competent observers—Richard Schlegel and G. J. Whitrow, for example—have emphasized, this proof that the special theory is conceptually invalid has never been refuted except by making assumptions that contradict the basic principles of the special relativity theory itself (such as the introduction of “motion relative to the fixed stars”). But this has degenerated into an emotional issue in which logical reasoning has been shunted aside. As Dingle says, it has simply “become impossible for mathematical physicists to believe that this theory can be wrong”, and when anyone such as he points out just how matters actually stand, they resort to “one esoteric evasion after another”, as the letters printed in *Nature* clearly demonstrate.

Professor Dingle characterizes this as a “tragic” situation for science, and, concludes his letter with a warning that is well worth careful consideration. We should, he says “take such steps as will ensure that in science the traditional absolute authority of reason and experience over automatic adherence to any theory, however attractive and temporarily successful, is restored before the inevitable consequences of neglecting that duty come upon us.”

—Dewey Larson, Portland, Oregon

SOME REFLECTIONS AND COMMENTS

Since my return from the speaking trip through the East and Midwest that I undertook in April and May I have spent considerable time reviewing and analysing the questions that were asked in the course of the long question and answer sessions that followed each of the eight talks that I gave to college audiences. My primary objective in so doing was to determine just where the most difficulty is being experienced in following my explanation of the development of theory from my basic postulates, so that I can give special emphasis to these points in my next book. In the meantime, however, my conclusions may be of interest to some of those who took an active part in the discussions.

Evidently the thing that is needed most is a better understanding of the general nature and scope of my new development. It is particularly important to realize that I am not only proposing some significant changes in physical theory; I am going a big step farther and proposing replacement of the fundamental physical concept on which all physical theory is based. Without a recognition of this point it is not possible to appreciate the full significance of much of what I have done.

Physical theory is not constructed in a vacuum. Before any theory can be devised we must have some general idea as to the nature of the universe about which we are going to theorize, some kind of a "general conceptual system", as one British author puts it. The currently accepted concept is that we live in a world of matters a world in which material "things" exist in a setting provided by space and time. This is the concept that underlies not only all of the orthodox physical theory of the moment but the entire structure of scientific and philosophical thought.

For obvious reasons, changes in the basic concept of the nature of the universe are seldom made. So far as the record reveals, such a change has occurred only once in all human history. For the first hundred thousand years or so of the existence of our species the prevailing concept was that of a world of spirits, in which superhuman beings or agencies dealt with natural phenomena in the same manner that man himself deals with the things and processes that are under his control. But some three or four thousand years ago it began to be recognized by the more advanced thinkers that the "spirit" concept was no longer adequate to meet the new demands that were being made upon it by reason of the emergence of a new way of looking upon physical phenomena, the beginning of that which we now know as science. All proposals for change met with strong resistance, of course, both from the "Establishment" and from the rank and file, but ultimately the "matter" concept prevailed, and it has served as the foundation for all physical theory ever since.

As I pointed out wherever I spoke, the tremendous advances in physical knowledge in the intervening three thousand years have brought us to the point where the "matter" concept is now in the same position that the "spirit" concept occupied in the days of the ancient Greeks; that is, it is no longer adequate to meet the demands upon it. This is the kind of a thing that is seldom brought to our attention, simply because there is no purpose to be served by moaning about the inadequacies of our tools and equipment so long as there is no visible prospect for improvement. But once the issue is raised the answer is

clear. In the words of P. A. M. Dirac, some “drastic change in our fundamental ideas” will be necessary before current problems can be solved. The “matter” concept has not only failed to give us theories that are adequate to deal with the vast amount of new phenomena discovered by observation and experiment in recent years, but is directly contradicted by some of these phenomena, particularly the “annihilation” reactions in which electrons and positrons, or similar pairs of so-called “anti-particles” are converted into photons of radiation. This transformation of matter into nonmatter is, of course, impossible in a world in which the *basic* entities are material “things”, and the undeniable fact that it does take place is a body blow to the “matter” concept of the universe—a fact that must sooner or later be generally recognized.

The existing situation definitely calls for replacement of the “matter” concept, and my proposal is that it be replaced by the concept of a universe of motion, in which all physical entities and all phenomena are manifestations of motion. This idea itself is nothing new. The “motion” concept has some quite obvious potentialities that have commended it to many investigators, and such men as Descartes, Hobbes, and Eddington have made strenuous efforts to work out a practical theory on the “motion” basis. Such attempts have been uniformly unsuccessful, but my studies have revealed that the failure was not due to any shortcomings of the “motion” concept itself but to the fact that these previous investigators did not realize that the conventional idea of the nature of space and time is a creature of the “matter” concept of the universe, an arbitrary assumption that has no place in a universe of motion. When this situation is seen in its true light and space and time are redefined in a manner consistent with the “motion” concept, the way is opened for a comprehensive and accurate new theory of general applicability.

Many of the features of the new theory seem strange, perhaps even incredible, on first consideration, but it should be realized that this initial reaction is a result of trying to fit the new ideas into the pattern of existing thought, a pattern that is based on the “matter” concept, whereas in order to arrive at a valid judgment it is necessary to view the theory in the context of the “motion” concept. For example, the simple basic motions, as envisioned in the new theory, are not motions of anything; they are simply motions: specific relations of space to time. I am often told most emphatically that such a thing is impossible; that motion is necessarily motion of something. But those who are so positive on this score are laying down a principle that is valid only in application to a universe of matter, and has no place in a universe of motion. If the basic entities of the universe are material “things” and motion is a property of those “things” then, of course, the objectors are correct; matter is logically prior to motion, and there can be no motion that is not motion of something. But if this is a universe of motion, in which matter is a complex of motions, then motion is logically prior to matter, and there must be simple motions before there can be matter or motion of matter. Hence the existence of these simple motions is not only logical but essential in a universe of motion. As I explained in our discussions, the mathematics of motion of matter are equally applicable to the simple motions, since an equation such as $v=s/t$ has no term representing the “something” regardless of the kind of motion that is involved.

The manner in which the accepted basic concept of the nature of the universe controls and restricts scientific thinking can be seen very clearly if the orthodox theory of the

structure of the atom is examined critically. On the basis of the “matter” concept material aggregates must be constructed of some kind of basic units. The concept of a world of material “things” simply *demand*s that complex material structures be built up from elementary unit of matter. Originally it was thought that the atom itself was the elementary unit, as the name “atom” implies, but when it was discovered that atoms disintegrate under certain conditions it became necessary to look for smaller elementary units, and since the sub-atomic particles appear to be the only candidates for this role, it has been taken for granted that they are the building blocks. The currently favored hypothesis of an atom constructed of electrons, protons, and neutrons is simply the most plausible combination that the theorists have been able to devise.

The development of a hypothetical structure on this basis has been no easy task. In fact, the point that I want to emphasize here is that the expedients that have had to be used for this purpose are so drastic and so utterly without independent justification of any kind that the attempt to construct an atom from “elementary particles” would undoubtedly have been given up long ago had it not been for the fact that the “matter” concept of the nature of the universe left no alternative. From its very beginning the “nuclear atom” hypothesis was in serious trouble, and it could not even get a start without postulating a pattern of behavior for the presumed constituents of the atom that defies the physical laws that these same particles follow implicitly wherever we can actually observe them. The “nuclear force” that is supposed to hold the components of the hypothetical nucleus together, and the mysterious something that gives the neutron a stability in the atom that it does not have elsewhere, are purely ad hoc assumptions without a shred of factual evidence to support them.

Furthermore, it is now clear that this atomic theory cannot be maintained without abandoning some basic philosophical principles of great significance, such as causality and physical continuity. In today's picture of the world of the atom there are events happening without cause, objects which appear first at location A and then at location B without having been anywhere in the meantime, and other occurrences equally inconsistent with our ordinary concept of rationality. The apologists for current scientific thought are trying to make the best of this state of affairs and portray it as an advance in our understanding of nature, but when we realize that all of this hatchet work that is being done on long-standing physical laws and philosophical principles serves no other purpose but to avoid the necessity of abandoning the concept of a universe of matter, it is certainly in order to suggest that we are paying much too high a price. The theory that I have developed on the basis of the concept of a universe of motion requires no such questionable tactics. It employs no ad hoc assumptions or principles of impotence to evade contradictions, and it arrives at a picture of the physical universe that is completely rational and understandable.

Some of the new and rather surprising phenomena that result from the reciprocal space-time relation, such as motion in time, require a certain amount of mental reorientation, to be sure, but motion in time actually *could* be possible even in the context of a universe of matter. In a universe of motion it is secured and it plays a very important part in the clarification of many hitherto unresolved physical problems. In fact, the introduction of motion in time and other related phenomena into the theoretical picture is

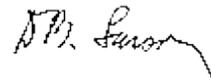
largely responsible for the rather spectacular results that have been obtained from the new structure of physical theory.

It is particularly significant that a number of the most important results of the new theoretical development—the explanations of the origin of gravitation and the nature of the photon of radiation, for example—are immediate and direct results of the postulates of the new system of theory, essentially obvious once the general nature of the change that is being made in the basic viewpoint is clearly understood. The remark of one reviewer with respect to the explanation of the recession of the galaxies, Seen from this angle the expansion of the universe is self-evident, might equally well be applied to the new explanations of some of these other basic phenomena. For this reason, it is a fairly simple undertaking, aside from whatever effort may be required to change one's pattern of thinking from the "matter" basis to the "motion" basis, to check the validity of this initial portion of the development, and the results in this area are more than adequate, in themselves, to establish the new theoretical system as a major advance in physical understanding. Whether or not one should take the time that would be required in order to understand the new theory in detail is largely a question as to how much advantage he feels that he would gain by getting in on the ground floor of a significant new development.

The initial emotional reaction to any proposal for a major change in basic thought is almost invariably antagonistic, unless the individual involved is already disenchanted with the prevailing pattern of thinking, but I believe that if the points that have been discussed in the foregoing paragraphs are carefully considered it will be clear that this proposal of mine for a change in our basic physical concept and in fundamental theory is something that warrants the attention of anyone who is concerned about the foundations of physical science or philosophy. As expressed by one of the reviewers of *New Light on Space and Time*, Professor Schmeidler of Munich, "a branch of science which takes its task seriously" has an obligation to make a "most careful investigation" of all features of this new development, even though, as he says, "a considerable effort" will be required.

A good start has been made toward getting that "careful investigation" under way. Almost all university and major college libraries in the U. S. and Canada now have at least some of my books on their shelves, nearly a dozen institutions are using or have used one or another of the books for classroom study, and I am receiving an increasing number of invitations to present the theory personally. There have been some obstacles, largely financial, that have stood in the way of accepting very many of these invitations, but by scheduling a number of stops on one trip, as I did this time, I may be able to get around more. In any event, it can be said that definite progress is being made.

D. B.



Larson

SOME ANNIVERSARY THOUGHTS

This issue of *Reciprocity* marks its fourth anniversary, and provides a suitable occasion on which to make some comments with respect to the progress that has been made toward the objective that was defined in the first issue: promotion of understanding of the Reciprocal System of physical theory. The most serious obstacle in the way of a new theory in any field is the prevailing tendency to dismiss it summarily on the ground that the a priori probability of its being correct is too low to justify taking the time to examine it. In the sixteen years that have elapsed since the first publication of the theory, and particularly in the four years that *Reciprocity* has been in existence, much of this initial handicap has been overcome. While unwillingness to consider the theory on its merits is still our biggest problem, there is a growing awareness that no serious arguments have thus far been advanced against it. Consequently, there is an emerging tendency, especially in foreign countries, to regard it as a legitimate competitor of currently accepted physical thought, and to recognize its extraordinary potentialities. As expressed in the long review of *Quasars and Pulsars* that was reprinted in the April 1974 issue of *Reciprocity*, “If it [the Reciprocal System] does [stand the test of time] the physicists will find in it their long-cherished desire, viz. one comprehensive theory with universal applicability.”

This review from the *Indian Journal of Physics* is one of the best available tools for use by those who want to get friends and associates interested in the theory, and if any readers would like to obtain a quantity of copies for distribution, a good supply is still available. They can be obtained free of charge either from me or from Professor Meyer.

In view of the amount of progress that has been made, I believe we are now in a position to take a somewhat more aggressive attitude, and to emphasize that the Reciprocal System complies fully with the basic requirement of science—agreement with observation and measurement—whereas so-called “modern” science no longer does. “If it disagrees with experiment it is wrong”, says Richard Feynman. “In that simple statement is the key to science.” But present-day scientists have been frustrated in their attempts to explain recently discovered phenomena in terms of theories that agree with the observed facts, and because they feel that they must have *some* kind of an explanation in each case, they have abandoned the traditional requirement that Dr. Feynman sets forth in the foregoing quotation. In my publications I have pointed out a great many places where present day physical and astronomical theory violates this principle that is the “key to science”, and resorts to one evasive device after another to conceal the failure to meet established scientific standards.

The currently accepted nuclear theory of atomic structure is a good example. According to the theory, the atom has a “nucleus” composed of protons and neutrons. If we go entirely by what we *know*, and require our theories to agree with known facts, the nuclear theory must be rejected because our observations show that (1) protons repel each other, and (2) neutrons only live about 15 minutes. But the theorists have taken the stand (which they call unscientific when anyone else relies upon it) that the known facts do not apply where they are in conflict with this theory. In order to “save” the theory they have assumed, entirely ad hoc, that there must be a “nuclear force” holding the protons in

place (the modern equivalent of the “angels” or “demons” that early-day scientists postulated when faced with similar situations), and that the neutrons must have an indefinitely long life when they are inside the atom. There is not the slightest independent evidence that either of these assumptions is valid. In essence, they amount to nothing more than assertions that for the purposes of the nuclear theory these particular conflicts with observation must be disregarded.

It is now appropriate, in my estimation, to begin laying more stress on the fact that there are no ad hoc assumptions in the Reciprocal System. Indeed, there are no assumptions at all other than the assumptions that define the theory: those that are contained in the two fundamental postulates. Nor does anything that has thus far been definitely deduced from the basic premises of the theory conflict with any definitely known facts. Here is a theoretical system that is in full compliance with the fundamental scientific requirement stated by Dr. Feynman: a requirement that “modern” physical theory is far from being able to meet.

—*Reciprocity*, Vol. V, No. 3 (October 1975)

A Note on Metaphysics

Some of the readers of my latest book, *The Neglected Facts of Science*, are apparently interpreting the conclusions of this work as indicating that the Reciprocal System of theory leads to a strict mechanistic view of the universe, in which there is no room for religious or other non-material elements. This is not correct. On the contrary, the clarification of the nature of space and time in this theoretical development removes the obstacles that have hitherto prevented science from conceding the existence of anything outside the boundaries of the physical realm.

In conventional science, space and time constitute a framework, or setting, within which the entire universe is contained. On the basis of this viewpoint, everything that exists, in a real sense, exists *in* space and *in* time. Scientists believe that the whole of this real universe is now within their field of observation, and they see no indication of anything non-physical. It follows that anyone who accepts the findings of conventional science at their face value cannot accept the claims of religion, or any other non-material system of thought. This is the origin of the long-standing antagonism between science and religion, a conflict which most scientists find it necessary to evade by keeping their religious beliefs separate from their scientific beliefs.

In the Reciprocal System, on the other hand, space and time are *contents* of the universe, rather than a container in which the universe exists. On this basis, the “universe” of space and time, the physical universe, to which conventional science is restricted, is only one portion of existence as a whole, the real “universe” (a word which means the total of all that exists). This leaves the door wide open for the existence of entities and phenomena outside (that is, independent of) the physical universe, as contended by the various religions and many systems of philosophy.

Inasmuch as the Reciprocal System is a theory of the *physical* universe only, it arrives at no conclusions as to the validity of the contentions of the various non-scientific schools of thought, but it removes all justification for the assertions that are frequently made to the effect that those contentions are scientifically impossible. Those scientists with strong religious convictions who are now looking askance at the Reciprocal System under the mistaken impression that it envisions a purely materialistic universe should, in fact, welcome it, because it removes the basic conflict between science and their religious beliefs.

A REJOINDER TO K. V.K. NEHRU

In a letter published in the May 1975 issue of Reciprocity I stated that I preferred not to comment on articles submitted for publication because “I believe that it is very desirable to encourage free and open discussion of the (Reciprocal) theory and its applications, so that we can have the benefit of as many points of view as possible in extending and clarifying the theoretical structure. I want to avoid saying or doing anything that might give the impression that I am trying to discourage dissenting opinions.” These considerations are still applicable, but I think that we have now reached the point where it would be appropriate to discuss the general situation with respect to the extension and refinement of the theory. The article by Dr. Nehru in the Autumn 1982 issue provides a good example of some of the points that need to be emphasized.

The first fact that should be noted is that the theory is derived in its entirety from the fundamental postulates; that is, it consists entirely of the postulates and their necessary consequences, without any content from other sources. This is very important, because it provides the basis for verifying the validity of the theory by application of the probability principles. In physical matters we cannot obtain mathematical certainty: a condition in which the probability of error is zero. We have to settle for what we may call physical certainty: a condition in which the probability of error is so small that it is negligible. This is attained by making a very large number of comparisons with the data from experience. Every comparison of this kind is a test of the theory, and each additional test that is made without finding a discrepancy reduces the probability that any discrepancy exists anywhere. But the theory cannot be tested by comparison with what little is known about a poorly understood phenomenon such as the pulsars. The definitive test is the comparison with the observational knowledge about phenomena that are well known and clearly understood. Since the Reciprocal System has already passed this test in thousands of comparisons, its validity is as clearly established as is possible for a physical theory (even though this fact is not yet realized by the scientific community in general).

It needs to be recognized, however, that the fixed character of the theory that enables establishing its validity also imposes some severe constraints on its further development. In particular, it prohibits introducing any additional assumptions, or anything from observation, in developing the details of application of the theory to specific areas. In order to preserve the status of the theory as a single, integral entity that can be tested as a whole these details must be derived in the same manner as the major conclusions; that is, as necessary consequences of the basic postulates. During the years that have elapsed since the founding of what is now the ISUS, many of those who have participated in the activities of the organization have decided that they would be better satisfied if the conclusions derived from the theory in certain areas were modified. But as I have just pointed out, the chief merit of the theory, the characteristic that enables us to verify its validity, is its status as a fixed structure, one that we cannot modify to suit our preferences or prejudices.

It does not follow that those of us who have undertaken to develop the details of the theory have necessarily arrived at the correct conclusions in every case. None of us makes any claim to infallibility. Thus it is entirely in order for anyone to take exception

to a previous conclusion, providing that he can show that a different conclusion can be derived from a development of the consequences of the fundamental postulates. But if the dissenting opinion is based, either totally or partially, on considerations other than those derived from the postulates of the Reciprocal System it is an expression of a different theory, and it has no claim to a favorable reception by those of us who are working to extend and amplify the Reciprocal System.

This task that we now have ahead of us is to enlarge our area of coverage and apply it to more of the details, meanwhile reexamining and refining the conclusions previously reached that may involve uncertain aspects. We are not looking to see if the theory can produce the right results. We already know, on the strength of the laws of probability, that it is capable of producing the answers that we want. Whether or not we actually find them is not a test of the theory; it is a test of our ability to apply the theory. Even though we have the correct foundation, the answers do not appear automatically. Sometimes they are quite obvious, but more often we have to dig them out.

There are, of course, a multitude of areas still to be covered by the theoretical development. But the issues involved in these areas, such as the list of questions in Dr. Nehru's article, are not "tests of the Reciprocal System," as he calls them. The required tests have already been carried to the point where the results of additional tests have no significance. Dr. Nehru's questions merely amount to a list of some of the things that should be investigated by anyone who undertakes to extend the previous consideration of the pulsars into more detail. This kind of information serves a useful purpose, and we should welcome Dr. Nehru's contribution, but the only thing it "tests" is our ability as investigators.

As it happens, I have considered all of the points mentioned by Dr. Nehru in the course of the investigations that I have undertaken during the past several years in connection with the preparation of the new edition of *The Structure of the Physical Universe*. These investigations have disclosed that in all of the cases that Dr. Nehru mentions, the development of the Reciprocal System of theory produces answers that agree with the known facts. In one instance some modification of the previously published conclusions is required. In all of the other cases my finding is that the previous conclusions are correct, as far as they go.

Most of these matters require more explanation than I can give here, but the first three are relatively simple, and a few comments about them will serve to illustrate the points that I have been making. Dr. Nehru's first question is why the quasars do not pulse as the pulsars do. The answer is that they actually do pulse as they pass through the pulsation zone, but we cannot detect the pulses because they originate from billions of stars and the radiation from these stars is not synchronized. In the second item he points out that the duration of the pulse should be in the range of one unit of time, rather than in seconds, as observed. But the unit of time applies to the unit of mass. The observed pulse is a composite of a vast number of sub-pulses, and it continues as long as there are mass units in the line of travel.

The third item is the reason for two peaks in the pulses of some pulsars. Dr. Nehru says that "no explanation has been offered for this from the framework of the Reciprocal

System.” This is true. But it is true only because, prior to my recent studies, the results of which have not yet been published, no one had gotten around to examining the question. Just as soon as I had occasion to take a look at the situation, I found the answer obvious. From the explanation of the nature of the pulsars that we derive from theory, it follows that the shape of the pulse is determined by the shape of the pulsating object, specifically its radio structure. The young pulsars, type S as they are known to the astronomers, have pulses with single peaks, which are quite evidently produced by globular structures. The older pulsars, type C, have had time to develop the typical dumbbell form of radio structure, and the double peak simply reflects the existence of this double structure.

These results are typical of those that I have obtained in the astronomical investigation (which I expect to complete in a few more months). Throughout the astronomical field I have found that the application of the Reciprocal System of theory provides simple and logical answers to the outstanding problems. Inasmuch as the extreme conditions to which astronomical objects are subjected stretch physical theory over the widest possible range of application, the fact that the principles and relations developed in the more accessible realms of physical science can be extended to astronomical phenomena without any serious difficulty is very significant.

I do not mean to imply, however, that this is an easy task. In a separate communication Dr. Nehru has raised another issue that brings out the point that exploration of a totally new field of thought, such as that which we are undertaking, is not a simple matter. He notes that my explanation of the destruction of the heavy elements at the stellar temperature limits asserts that the combined space displacement of the ionization and thermal motion neutralizes the rotational time displacement of the atom, and reduces all motion to the linear form. In order to accomplish this, Dr. Nehru comments, the thermal motion must, in some way, be converted to rotation. “The thermal motion, being a Linear space displacement, cannot directly destroy the atomic rotation,” he says. Actually this is not correct. It would be true if we were dealing with vectorial motion, but all of the motions with which we are here concerned are scalar, and the scalar situation is quite different.

This is a good illustration of the fact that, even though the theory has the answers that we are looking for, these answers are by no means self-evident. I believe that I have a reasonably good understanding of the primary consequences of the postulates of the Reciprocal System. Furthermore, I recognized the scalar nature of the basic motion, and emphasized it in my first book, published in 1959. But it was not until two or three years ago that I had a clear enough understanding of scalar motion to be able to answer the point that Dr. Nehru now brings up, if anyone had raised the issue earlier.

The key to this situation (and to most other questions about the basic motions as well) is a recognition of the way in which rotational scalar motion differs from rotational vectorial motion. The difference can easily be seen if the motion of a point the surface of a rotating ball (a vectorial motion) is compared with that of a point on the surface of a rotating expanding balloon such as the one that I described in *The Neglected Facts of Science*. In the vectorial case the primary motion of the point is transverse, and the acceleration toward the axis of rotation causes it to move in a circle around that axis. In the scalar case the primary motion of the point is radial, and the rotation of its representation in the

reference system causes the point to move spirally outward. The rotation of the atom is a scalar motion similar to the rotation of the expanding (or contracting) balloon. The thermal motion is a linear scalar motion that simply adds to, or subtracts from, the magnitude of the radial motion whose direction is being changed by the rotation. Attainment of equality between the scalar magnitudes, the space and time displacements, thus destroys the rotation.

In my opinion, there is no doubt that whatever problems may exist in other physical areas can similarly be solved by application of the basic principles and relations that we have derived from the postulates. I am therefore suggesting to those who are inclined to tackle these problems that you ought to approach them with the firm conviction that the answers exist, and that they can be obtained if sufficient time and effort are applied, along with a little ingenuity.

COMMENTS ON SOME ISSUES RAISED AT THE 1978 CONFERENCE

It is not possible in the short time that is available in the conference sessions, to give full consideration to all of the issues that are brought up, and most of the discussions were elaborated to a considerable extent in informal conversations outside the regular sessions. A few comments on some of the more important points may be of interest to those that did not happen to be present when these particular issues were discussed.

Energy at high speeds:

One of the questions that came up was what happens to the energy at very high speeds. This is one of the multitude of issues that have not yet been studied in the context of the Reciprocal System because of the limited amount of time and effort that have thus far been available for the task. I was not able, therefore, to do any more than suggest the possible nature of the answer at the conference. Since my return home I have given some further thought to the matter, and while some of the details need more study, I believe that the general picture is now reasonably clear.

In a universe of motion the condition of rest, the datum level from which all physical activity extends, is unit scalar motion in each of the three dimensions. Units of speed (measured as displacement from the unit level) may be added, bringing the displacement up to the +2 level (speed 2/1) or subtracted, bringing the displacement down to the -2 level (speed 1/2). Since motion exists only in discrete units fractional units of simple motion are not possible. This situation is represented by diagram A.

	A							
Untts
(1) From zero datum	0	1	2	3	4	5	6	
(2) From natural datum	-3	-2	-1	0	+1	+2	+3	
(3) Speed	1/4	1/3	1/2	1/1	2/1	3/1	4/1	
(4) Energy	4/1	3/1	2/1	1/1	1/2	1/3	1/4	

Line (1) is expressed in speed displacement units measured from the zero datum. Line (2) is the same measured from the natural datum. Lines (3) and (4) are the corresponding values. By an appropriate process such as a powerful explosion, units of speed displacement can be added to an object, accelerating it successively from -3 to -2, -1 and 0. It then enters the high speed environment and is further accelerated by environmental influences.

The units of motion represented in this diagram are all directed inward as no further speed can be added to the unit outward progression. But where there is no effective motion in two of the three dimensions (that is, the speed is unity) geometric combinations of inward and outward motions with fractional net inward speeds may exist in the third dimension. These compound motions are the motions of our ordinary experience: motions of masses. The inherent scalar motion of the mass unit (the gravitational motion) is an inward motion at unit speed: the kind of a unit in which line (1) of diagram A is expressed. In the compound motion, an outward, or reverse, motion is applied to the mass in the form of successive units of what we may call *reverse energy*. The result of this process in terms of the net speed and energy of the compound motion is shown in diagram B.

	Minimum	Maximum
Speed		
Mass	1/1	1/1
Reverse speed	-1/1	-1/∞
	———	———
Net	0	1/1
Energy		
Mass	1/1	1/1
Reverse energy	-1/1	-∞
	———	———
Net	0	-∞/1

When the first effective unit of reverse energy is applied to the one effective energy unit of the mass, the net energy is $1-1 = 0$. One additional unit produces $1-2 = -1$. The corresponding figures for net speed are $1-1 = 0$, and $1-\frac{1}{2} = \frac{1}{2}$. The net speed (the observed speed) is therefore a fractional inward unit. If the process could be carried to completion, the reverse speed would be $1/m$ and the net speed would be a full unit (the speed of light). But this point cannot be reached as it would require an infinite amount of reverse energy.

Here, then, is the answer to the question raised at the conference. As the net speed approaches unity the energy approaches infinity, not because of any change in the mass, but because adding energy does not increase the speed directly; it accomplishes the increase by reducing the reverse speed component, and the most that can be accomplished, even by an infinite amount of energy, is to reduce that reverse component to zero. This does not preclude reaching speeds greater than unity by direct addition of units of speed, as indicated in diagram A.

Conservation:

The postulates that define the physical universe do not provide any means whereby motion can be created or destroyed. Total motion is therefore conserved; that is, the total quantity of motion remains constant. This motion can be measured either as speed s/t , or as energy t/s . In either case the total number of units is the same. If the motion is expressed in terms of energy all of the phenomena of the cosmic sector take place within the units of energy; while if the motion is expressed in terms of speed all of the phenomena of the material sector take place within the units of speed, as indicated in diagram B. The quantity that is conserved is the number of complete units, energy in the material sector and speed in the cosmic sector.

Conservation is absolute only in application to total motion, but it can be applied to different forms of motion with the qualification that it is applicable only to the extent that there is no transfer to or from any other form of motion. The conservation laws, other than the one applying to total motion, cannot be used where any transformation process is involved nor can they be used as an argument against the existence of a transformation process.

Current electricity:

Inasmuch as the electron is in effect, a rotating unit of space, the movement of electrons (space) through matter is essentially equivalent to movement of matter through space and it is subject to exactly the same basic relations. The physics of current electricity applies to the *mechanical* aspects of the one-dimensional particles (electron and positron) rather than to their peculiarly electrical properties. We may therefore deal with current electricity by the usual methods of mechanics, using the same mathematical expressions, and if we wish, the same terminology. The quantity of electricity, the number of electrons (units of space), can be expressed in centimeters, or some other space unit, just as well as in units such as coulombs. The rate of current flow is the number of electrons per unit time, and it can be expressed in cm/sec just as well as in amperes. Resistance is mass per unit time, and it can be expressed in grams per second, or some equivalent unit. This is not the mass of the electron which is massless, but the mass through which the electron moves.) The product of resistance and time, Rt , is mass. In order to get the energy of the flow (the amount of heat imparted to the conductor) we use the same expressions that we apply to ordinary motion. This energy is $\frac{1}{2} mv^2$, or in electrical terms RtI^2 . Or it can be obtained as the product of force and distance. Electromotive force, measured in volts, is no different from any other force, and could be measured in any other force units. The distance is the electrical quantity, or the more easily measured product of the current and the time. The energy is then VI .

While the motion of space (electrons) through matter has the same mechanical properties as the motion of matter through space, it is nevertheless a different phenomenon and it has some properties of its own. These are governed by a set of purely electrical relations. A whole new class of phenomena develops when the electrons acquire charges. In their early history static and current electricity were recognized as two different phenomena but since charges are easily produced and easily destroyed there is considerable interplay between the two, and the distinction has largely been lost. This has introduced some confusion. For instance, electric charge, which is a motion is expressed in the same units

as electrical quantity, which is space only. As long as we deal separately with charge and quantity, each in its own context the fact that "coulomb" has two entirely different meanings does not result in any difficulty. But such confusions obviously stand in the way of a clear understanding of the phenomena that are involved.

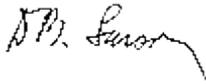
Potential energy:

The gravitational motion of an atom is constant, but because it is distributed in all directions the portion of this motion that is exerted in the net direction of movement is only a fraction of the total. The energy of this portion of the motion is kinetic energy. The remainder of the total energy is potential energy. As the net motion in the direction of greatest mass effect continues, the portion of the total motion that is directed toward a given area in that direction increases inversely as the square of the distance by reason of the geometrical relations. The motion is therefore accelerated, and the kinetic energy is increased at the expense of the potential energy.

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.”

[Beyond Newton](#)

“...Recommended to anyone who thinks the subject of gravitation and general relativity was opened and closed by Einstein.”

[New Light on Space and Time](#)

A bird’s eye view of the theory and its ramifications.

[The Neglected Facts of Science](#)

Explores the implications for physical science of the observed existence of scalar motion.

[Quasars and Pulsars](#)

Explains the most violent phenomena in the universe.

[Nothing but Motion](#)

The first volume of the revised edition of *The Structure of the Physical Universe*, developing the basic principles and relations.

[Basic Properties of Matter](#)

The second volume of the revised edition of

The Structure of the Physical Universe, applying the theory to the structure and behavior of matter, electricity and magnetism.

[The Universe of Motion](#)

The third volume of the revised edition of *The Structure of the Physical Universe*, applying the theory to astronomy.

[The Liquid State Papers](#)

A series of privately circulated papers on the liquid state of matter.

[The Dewey B. Larson Correspondence](#)

Larson's scientific correspondence, providing many informative sidelights on the development of the theory and the personality of its author.

[The Dewey B. Larson Lectures](#)

Transcripts and digitized recordings of Larson's lectures.

[The Collected Essays of Dewey B. Larson](#)

Larson's articles in *Reciprocity* and other publications, as well as unpublished essays.

Metaphysics

[Beyond Space and Time](#)

A scientific excursion into the largely unexplored territory of metaphysics.

Economic Science

[The Road to Full Employment](#)

The scientific answer to the number one economic problem.

[The Road to Permanent Prosperity](#)

A theoretical explanation of the business cycle and the means to overcome it.

These works are free at; <http://www.reciprocalssystem.com/dbl/index.htm>

Special Thanks to the folks who set up the Dewey B Larson website!