From; http://www.reciprocalsystem.com/nfs/index.htm

The Neglected Facts of Science

DEWEY B. LARSON

REACTIONS *and* REVIEWS

"After a few pages, you will see that there is obviously very much that is wrong with the standard Big Picture—the Big Bang, quasars, et al. Larson ticks off anomalies and unfounded speculations one after the other. For example, all stars regardless of age possess some heavy elements, but theory does not account for all of them. Whence the X-ray background of the universe? Is the General Theory of Relativity viable? After finishing this book, you may wonder if there is any firm ground left for the astronomer to stand upon."

—*Science Frontiers*

A Review by Henry A. Hoff

Any student of Velikovsky, as yet unfamiliar with Dewey B. Larson, might wonder from the title of this book if it contains a compendium of facts presented by Velikovsky and his supporters that have been neglected by the scientific establishment. It is certainly a book of facts neglected by the establishment, but no book of 131 pages could present that many facts. Instead, it is a book of facts, evident from Larson's theory of the physical universe, that is certainly of interest to interdisciplinarians and may be of great importance to Velikovskians.

Velikovsky was raised and educated in Europe, while Larson is pure Americana. He was born on the plains of North Dakota in 1898 and spent his early years in Idaho. After an interruption for World War I in which he served as a 2nd Lieutenant in the Coast Artillery, he pursued an engineering degree from Oregon State University. After graduating in 1922, he was licensed by the State of Oregon as a mechanical engineer.

Although Larson and Velikovsky are alike in their insatiable curiosity and their drive to understand causal forces, their approches differ drastically. Velikovsky ventured into ancient history and astronomy from his research in psychoanalysis and developed an electromagnetic theory of the solar system, applicable to the Universe. Larson, on the other hand, explored theoretical physics from his background in mechanics and developed his physical theory based on *motion*.

To even begin the task of creating his own physical theory, Larson had to become familiar with prevalent theories. He is not an academian nor a researcher of the "Establishment". In the preface of one of his earlier books, *Nothing But Motion* (1974), he described himself as an "uncommitted investigator". Such an investigator is free of the economic politics of establishment science. Larson is an amateur in this sense only. In the course of his research, he has noted observations and theoretical facts deduced in his theory that have been and continue to be neglected by the professionals; hence this his latest book.

At the heart of his theory and the first concept he presents to the reader is what he calls *scalar motion*. A scalar is the magnitude of a vector. In Larson's theory it is a motion itself. The concept is difficult to convey and Neglected Facts is written to help explain, as well as to point out evidence from astronomy, that scalar motion and its variety of forms exist.

His universe of scalar motion, called the Reciprocal System of Theory, is algebraic and 3D Euclidean, making it a complex entity to visualize. It has many surprises. Motion, not matter, not energy, not charge, is the basic entity that occurs in discrete units. The concept of objects moving and the interactions of these objects inside a container (the science of kinematics) seems intuitively obvious, as does the idea that all effects must have their causes within the container. Larson claims these ideas are wrong. In his theory there is no "container" for objects to move around in. To him the "container" is a local imperception. He conceives of causes outside this subjective "container" of our holocentric viewpoint, producing effects inside the "container". This exterior causal zone he refers to as the inverse or cosmic sector of the universe (where antimatter exists).

There is what Larson refers to as "distributed scalar motion". He introduces this idea in his first chapter "Fundamentals" and refers to a variety of its possible forms throughout the text. Any such motion : can have either an inward or an outward direction, yet has no pinpointable reference frame. When a reference frame is assigned, an object is created relative to that reference frame. And the object can be observed to follow any path.

This property of distributed scalar motion is one "neglected fact". Throughout the text he labels observations of or deductions about scalar motion as either neglected, disregarded, or unrecognized facts. It would have been a great help to the reader if Larson had included a table of these facts somewhere. With this table the reader could locate appropriate pages and gain a clearer understanding of these facts.

Larson does say that some facts have much more significant consequences than others. These he calls *crucial facts.* The existence of distributed scalar motion is such a fact. When the “disregarded fact” that every fundamental force must originate from a fundamental motion is considered, distributed scalar motion is found to explain the fundamental forces. It is found to explain electric charge and mass (inertial and gravitational).

In Chapter 2 he mentions that distributed scalar motions can have up to three dimensions, only one of which can be seen at any time from a local reference frame. That one is seen in three dimensions locally. These concepts do not appear to be deduceable from what he’s presented in Neglected Facts but instead appear to come out of nowhere. Unfortunately, it gives the reader the feeling that Larson is inventing “bizarre devices” - for his own theory - just like the ones he says others have invented to get Relativity theory to work: These concepts concerning distributed scalar motion are introduced in his previous books; and through the use of these multidimensional distributed scalar motions, Larson is able to unify electricity, magnetism, and gravity. If the motion is one dimensional, it is electric motion; two dimensional, it is magnetic; and three dimensional, gravitational.

Velikovskians will find his discussions of gravity interesting. Larson makes no mention of Velikovsky’s theory that gravitation is an electromagnetic phenomenon. To Velikovsky there is no need for gravity to act instantaneously or to be unique. Larson, on the other hand, claims that it is a unique force derivable directly from motion, and that it does act instantaneously (a “neglected fact”). But Larson’s point of view may be true only if gravitation is indeed the phenomenon being observed. Should local manifestations that are called gravitation prove to be electromagnetic phenomena, it may mean that Larson’s concept of gravitation needs to be reassessed.

Larson also tackles the idea of an absolute speed limit. He is willing to say that the absolute limit of the speed of light is erroneous. His limiting value of the total scalar speed of an object is 3c,
not c.

Time is not immune to new interpretation either. In the Reciprocal System, time can have three independent dimensions (an “unrecognized fact”). And space *can* move. These phenomena are the results of Larson’s postulation that space and time have meaning only in the motion equation. There is motion and direction in time, but not “time travel”.

The reader should be prepared for some mind-wrenching mental gymnastics that involve the fundamental aspects of Newtonian mechanics and its prodigy. The book is not easy to read. But doing so gives a healthy appreciation of the fundamental doubts many of the celestial minds of physics have toward mechanics, principally, and electromagnetics to a much lesser degree. Larson has included a good many sentences on the flaws of Relativity. He demonstrates that the elevation of the theory of Relativity above physical facts has produced the dangerous situation of discrediting the value of objective truth. His name can be added to the long list of scientists and mathematicians who have been pointing out again and again what is wrong with Einstein’s Theory of Relativity, yet it seems to fall on deaf ears.

The size of objects discussed—after he explains electrictricity, magnetism, and gravity -expands to include white dwarfs, quasars (as reported in his Quasars and Pulsars published in 1971), and supernovae. Ultimately, he discusses the current cosmological theories and shows how his theory, by attending to those facts neglected by others, does not need a Big Bang. The end result of his cosmological discussion is a cyclic or Steady State universe of motion in which there is a dynamic equilibrium between the cosmic sector and the material sector (where we are).

Of the observational facts Larson mentions in Neglected Facts none are laboratory reproducible. There is an inherent danger, then, in claiming that astronomically observable facts, not laboratory producible, show the existence of, or are the real effects named in, a theory. The danger lies in the unknown limitations that allow reproducibility of the phenomena being observed. Until these limitations are known, any theory that provides a description, which reasonably matches the observational facts, may be correct. It is for this very reason, that Larson's theory of motion needs to be considered. He does present some laboratory results in his books The Structure of the Physical Universe (1959) and The Case Against Nuclear Atom (1963).

Neglected Facts is an informative, well-organized book that flows steadily. After each section of presenting theoretical facts, Larson then presents physical and astronomical observations that may indeed represent the phenomena of his theory.

His efforts provide much food for thought.

Answer by D. B. Larson

Scalar Motion and Scalar Dimensions

In his review of The Neglected Facts of Science (KRONOS IX:2, pp. 70-73), Henry A. Hoff suggests that the two unobservable scalar dimensions are introduced ad hoc. Actually, they are necessary consequences of the existence of scalar motion, which, as I have shown, is established by observation. In a three-dimensional universe there are obviously three dimensions of that motion. That is what the concept of three-dimensionality means.

Hoff's problem in this case is the same as that of many others. They take it for granted that they know what the word "dimension" means, but they are thinking of geometric dimensions. The dimensions of scalar motion are purely mathematical, not geometric. The whole point of my discussion in Chapter 2 of The Neglected Facts of Science is that only one of the three scalar (mathematical) dimensions can be represented in the three spatial (geometric) dimensions of the conventional reference system. The other two scalar dimensions of motion are unobservable.

Dewey B. Larson, Portland, Oregon

Henry A. Hoff replies:

In the preface to The Neglected Facts of Science, Dewey B. Larson explains that his book is purely factual rather than purely theoretical, which was the case in his earlier books on motion. As such he is not obliged to demonstrate where concepts such as multi-dimensional scalar motion come from. To the reader working through Chapter 2, it is not intuitively obvious why any one of the three dimensions of scalar motion can have three local reference frame, Euclidean dimensions whenever a fixed reference frame is in use. A footnote to the appropriate page of *Nothing But Motion* would have sufficed.

Larson has written Neglected Facts more from his point of view than from the readers. The reader looks through conventional geometric "eyes" and tries to envision what Larson is talking about. To the geometrician, the idea of multi-dimensional scalar motion seems *ad hoc* because scalar motion seems *ad hoc.* That most galaxies demonstrate a red shift does not prove either Larson's contention that scalar motion exists, that these galaxies are all receding or that we are observing "tired" light because of the great distances involved. Astronomical observations cannot establish any theoretical concept; however, theoretical concepts can be used to explain astronomical observations and even predict new phenomena so as to lend credibility to the theory.

The point Larson makes in his letter that the dimensions of scalar motion are purely mathematical is an important one. By theorizing that scalar motions have a potential of nine degrees of freedom (three scalar dimensions) from which, for any conventional physical reference frame, any three (one scalar dimension) can be operating, he allows ample mathematical freedom to describe observations recorded in the conventional physical frame. This added mathematical freedom coupled to a commutative algebra has apparently allowed him to unify the previously nonunifiable "fields" or forces of physics.

Preface

Since many readers are aware that most of my previous publications have been devoted to presenting a new general physical theory, and discussing various aspects thereof, I should explain that this present work is totally independent of that theory. It simply fills a vacuum in existing science, identifying a number of physical facts that have been overlooked by previous investigators, together with other facts that are known, but are disregarded because they do not fit into the current structure of physical theory. When their consequences are fully developed, these hitherto neglected facts clarify many physical issues and provide the answers for a number of previously unsolved fundamental problems. The work should therefore be of interest to all who are concerned with the foundations of physical science, irrespective of whether or not they are inclined to spend the time and effort that are required to become familiar with a new theoretical development.

The plan of this work is the direct opposite of that of my previous books. In those publications, the presentation was *purely theoretical.* A set of postulates defining a universe of motion was formulated, and the necessary consequences of those postulates were then developed by logical and mathematical processes, without introducing anything from any other source. All of the conclusions reached in that development are independent of experience, and no use is made of the results of observation and measurement, except in comparisons with the theoretical results to show agreement between the two. This present work, on the other hand, is *purely factual.* It deals entirely with observable facts, and the necessary consequences of those facts, without introducing any theoretical ideas or concepts. It therefore has essentially the same status as a report of a series of experimental discoveries.

However, even though the contents of this volume are entirely factual–that is, limited to observed facts and the logical or mathematical consequences thereof–and are independent of the theory of a universe of motion that I have developed, they are, in a sense, products of that development, inasmuch as the results of the theoretical study provided the clues that enabled recognition of the previously neglected physical facts. Some comments about the theoretical development should therefore be appropriate.

For more than forty years I have been investigating the consequences that necessarily follow if we make the assumption that the universe in which we live is a universe of motion: one in which the basic entities are units of motion rather than units of matter. This is by no means a new idea. It has long been recognized that the discovery that matter can be transformed into non-matter, and vice versa, by appropriate processes, cuts the ground out from under the currently accepted concept of a universe of matter, in which the basic entities are assumed to be elementary units of matter existing in a framework provided by space and time. Over several centuries, a great deal of time and effort has been put into attempts to find an acceptable substitute for this now untenable concept. The only candidates thus far located that appear to warrant serious consideration are energy and motion. Energy is the current favorite, but as Werner Heisenberg, one of the principal supporters of this possibility, conceded, there is little likelihood that a workable theory can be constructed on this basis. The motion alternative has been extensively studied by many scientists and philosophers, including such prominent figures as Descartes, Eddington and Hobbes, but they have been no more successful than Heisenberg and his energy school of thought.

In spite of the uniform lack of success thus far, this is a task that cannot be abandoned, as we certainly cannot be satisfied to continue indefinitely with a basic concept that we know is erroneous. As it happens, I have been able to put the motion concept on a totally new footing by postulating that the universe is composed *entirely* of motion. On the basis of this concept, I have been able to formulate a set of postulates, the consequences of which constitute a *general* physical theory, one in which all conclusions in all physical areas are derived from the same set of premises.

A change in the base of the system naturally necessitates many modifications of the details of physical theory. However, the amount of change that is required is not nearly as great as might appear on first consideration, because the new development calls for very little change in the *mathematics* of present-day theory. The changes are mainly in the *interpretation* of the mathematics, in our understanding of what the mathematics *mean*. Since the case in favor of the currently accepted theories is primarily–often entirely–mathematical, there is little that can be said, in most cases, in favor of current theory that is not equally applicable to the mathematically equivalent conclusions that I have reached. The substantial advantages of a fully integrated general physical theory are thus attained without any violent disruption of the mathematical fabric of the physics of familiar phenomena. All that is necessary in most instances is some alteration in the significance attributed to the mathematical relations, and a corresponding modification of the language that is utilized. These new interpretations, integral parts of a consistent, fully integrated general theory, can then be extended to a resolution of the problems that are currently being encountered in the far-out regions.

When the true situation is more widely understood, it is probable that more individuals will be willing to spend the time and effort that are required in order to understand the new development. In the meantime, however, there are a number of places where the investigations in connection with the development of the new theory have disclosed some significant, and hitherto overlooked, physical facts that are independent of the physical theory in whose context they are viewed. These items stand on their own foundations, and they can be incorporated into physical thought without regard to the modifications that I am proposing in the general structure of physical theory.

The most important of these advances in physical understanding is the clarification of the nature and properties of scalar motion. The existence of this type of motion, which has magnitude only and no inherent direction, is undeniable, since we can observe it, but it has never previously been critically examined, probably because on casual consideration it does not appear to have any significant impact on physical activity. The results of my investigation indicate that this superficial impression is mistaken, and that scalar motion is, in fact, one of the primary physical phenomena. As will be demonstrated in the pages of this volume, clarification of the nature and properties of this type of motion opens the door to a greatly improved understanding of many aspects of the physical universe, including its large-scale structure and behavior.

CHAPTER 1

Fundamentals

The common analogy likens the galaxies to spots on the surface of a balloon that is being inflated. As the rubber stretches, all the spots move away from each other.

This statement, taken from a current astronomical text, can be found in almost any explanation of the recession of the distant galaxies, either in essentially these same words, or in terms of a threedimensional analog, such as the one used by Fred Hoyle, in which he compares the galaxies to raisins in a puddingexpanding in the oven. It testifies to the general recogniLion of the fact that the kind of motion typified by the movement of spots on the surface of an expanding balloon is, in some way, different from ordinary motion. This difference has not received any intensive scrutiny in physical thought, and is not given any attention in the textbooks. Indeed, the definition of motion is customarily expressed in terms that specifically exclude the kind of motion that we observe on the balloon surface. The results of the investigation reported in this present work indicate, however, that this special type of motion plays a significant part in many physical phenomena, and that a thorough knowledge of its nature and properties is essential for a full understanding of those phenomena.

As a first step in this direction, a critical analysis of the expanding balloon situation is in order. If the motion of the spots is examined in isolation, without placing the balloon in a reference system, or introducing a reference system into Lhe balloon, which can easily be done conceptually, or if a similar mental picture of the receding galaxies is constructed, there is no way by which the motion of any one spot, or of any one galaxy, can be distinguished from that of any other. The only identifiable change that is taking place is a continuous and uniform increase in the magnitude of the distances between spots, or between galaxies. All spots and all galaxies are moving outward at a constant speed, but they are moving outward in all directions, which means that the motions have no specific directions. Thus the *only* property of this type of motion is a positive speed magnitude. Such a motion is, by definition, scalar.

With a little further exercise of the imagination, we can make the analogy with the galaxies somewhat closer by replacing the balloon with an expanding three-dimensional object, perhaps some kind of a transparent expanding plastic ball, with visible spots scattered throughout its volume. Here, again, the motion of all spots is simply outward, and unless a reference system is arbitrarily introduced to provide directions, the only property of the motion is its positive (outward) magnitude.

This view of the expanding plastic ball that we derive by mentally abstracting the ball from the local environment, and considering it in isolation, is exactly the same as the view that we get from observation of the distant galaxies. The only thing that we know about the motions of these galaxies is that they are receding from our own galaxy, and presumably from all others, at speeds that increase in direct proportion to the distance, just as the relative speeds of the spots in the interior of the expanding plastic ball obviously do. What we observe, then is a *scalar* motion of the galaxies, a motion that has no property other than a positive magnitude.

The currently popular view is that the galactic recession results from a gigantic explosion in which the entire contents of the universe were thrown out into space at the speeds now observed. The radially outward motion in all directions is explained as the result of velocity differentials. On this basis, the galaxies in one direction are receding because they are moving faster than the galaxy from which we are observing them. In the opposite direction, the galaxies are presumed to be slower than ours, and we are therefore moving away from them. There is no way by which this kind of a distribution of motions, if it exists, can be distinguished from motion of the type illustrated by the spots in the expanding plastic ball. Regardless of its origin, motion of this kind has no inherent direction. Each identifiable point, or object, is simply moving directly away from all others. Any further characteristics that may be attributed to those motions to fit a theory or explanation of their origin are nof relevant to the existing physical situation.

The type of motion with which we are familiar in everyday life is *vectorial*. This is motion relative to a fixed reference system. Like scalar motion, it has a magnitude, but it also has a direction in the reference system, and the effect of the motion depends on this direction, as well as on the magnitude of the motion. The difference between the two types of motion can be brought out clearly by consideration of a simple example. Let us assume that a moving point X is located between two points Y and Z on the straight linejoining the two points. lf the motion of X is vectorial, and in the direction XY, then the distance XY decreases and the distance XZ inereases. But if the motion of X is scalar, as on the surface of the expanding balloon, or in the expanding plastic ball, *both* XY and XZ increase.

The scalar motions readily accessible to observation are not isolated in the manner of those that we have been considering, but are physically connected to the spatial reference system. This phvsical coupling supplies the vectorial directions (directions relative to the reference system) that the motions themselves do not possess. The entity that actually enters into physical phenomena is not the scalar motion alone, but this motion plus the coupling to the reference system. In the condition in which it is physically observed, the balloon or plastic ball is connected to a reference system by placing it in that system in such a manner that some point X of the expanding object coincides with a specific point A in the reference system, the reference point, as we will call it, and the outward motion XY of a spot Y coincides with a vectorial direction AB.

The universe as a whole cannot be placed in a reference system, but the same result can be achieved by introducing a system of axes into the universe. The origin of these axes is then the reference point. The Big Bang theory of the origin of the galactie recession introduces a conceptual reference point of this kind, the location of the hypothetical explosion, but leaves the vectorial directions undefined. Thus, aside from being incomplete, and conceptual rather than physical, this Big Bang hypothesis does the same thing as the placement of the balloon in a position in the reference system. It connects a scalar motion with a reference system.

A scalar motion physically coupled to a reference system in this manner may act in essentially the same way as a vectorial motion, in which case it is not currently distinguished from vectorial motion. Alternatively, it may have some quite different characteristics. Current science then does not recognize it as a motion. For an understanding of these hitherto unrecognized types of scalar motions, we will need to examine some of the fundamental facts that are involved.

These pertinent facts are not difficult to ascertain. They have hitherto remained unidentifief not because they are hidden orelusive, but because no one has looked for them. This, in turn, has been due to the lack of any clear indication that they might have a significant impact on physical understanding. After all, expanding balloons and plastic balls play no major part in physical activity. It is often asserted that issues in science are investigated for the same reason that men climb mountains — just because they are there to be climbed — but small mountains get scant attention, and seemingly insignificant physical phenomena generally receive the same casual treatment. An attitude of benign neglect is all the more likely to prevail where, as in this instance, some readjustment of thinking is necessary before the existing observational situation can be seen in its true light.

The resemblance between the motion of the receding galaxies and the motion of spots on an expanding balloon might have stimulated some interest in exploration of the nature and properties of scalar motion had it not been for the invention of the Big Bang theory, which seemed to provide an explanation of sorts for the galactic recession in terms of vectorial motion, although, as can now be seen, the recession is actually a scalar motion that is assigned a reference point by the theory. The explosion hypothesis is not available to the supporters of the rival Steady State theory, but they have neverdeveloped thedetails of how the recession is supposed to be produced in their theory, and the need for an explanation of the special characteristics of the motion of the galaxies in the context of that theory has gone unrecognized. The event that has finally focused the attention of an investigator on the scalar motion issue, and has prompted a detailed study of this type of motion, is the development of the theory ofa universe of motion. In this theory scalar motion plays a very significant part, and it duickly became evident that a full understanding of its nature and properties was essential to the theoretical development. This supplied the incentive for the investigation for which there had previously seemed to be no adequate reason. It should be understood, however, that the presentation in this volume stands on its own factual foundations, and is entirely independent of the theory that stimulated the investigation that produced the results now being described.

Although a scalar motion has no vectorial direction of its own, the scalar magnitude may be either positive or negative. The motion therefore has what we may call a *scalar direction*. This term may appear to be self-contradictory, inasmuch as the word “scalar” indicates a cluantity that has magnitude only, without inherent direction. But we do not ordinarily deal with scalar motion as such; we deal with its representation in the spatial reference system, and that *representation* is necessarily directional.

If the scalar magnitude of a motion is positive, the spatial result of the motion is that the distance from object A to object B increases with time; that is, the scalar motion is *outward*. Conversely, a negative scalar motion is *inward*, as seen in the reference system. The magnitude is positive or negative; the resulting scalar direction is outward or inward. A simple scalar motion AB is inherently nothing more than a change in the magnitude of the distance between A and B per unit of elapsed time, but it is equivalent in most respects to a one-dimensional vectorial motion, and it can be represented in a fixed spatial reference system of the conventional type in the same manner as the corresponding vectorial motion, with a direction in the reference system, a vectorial direction, that is determined by the nature of the coupling to the reference system. Ifhe vectorial direction, a property of the *coupling*, is independent of the scalar direction, a property of the *scalar motion*. Outward from point A, for example, may take any vectorial direction. Some conseduences of this independence of the directions will be discussed later.

Applying these general principles to the balloon example, we find that when the expanding balloon is placed in a reference system - on the tloor of a room, for example — the motion of each spot *acquires* a vectorial direction. This direction is totally dependent on the placement. lf point X is placed on point A of the tloor, and point Y is placed to coincide with some point B in the reference system at time t, then the motion XY has the diretion AB. If the correlation takes place in some other way — that is, if some point Z on the balloon surface is placed on point A, or if point Y coincides with some point C at time **t** - then all directions on the balloon surface, including the direction of the motion XY, are altered.

The direction AB is not inconsequential. It has an actual physical significance. For instance, the motion terminates if there is an immovable obstacle somewhere along the line AB. But this direction AB is a property of the physical coupling between the balloon and the reference system, not a property of the motion, and it can be altered without any effect on the motion itself. For instance, the expanding balloon can be moved. The only inherent property of the scalar motion of any one spot, its scalar magnitude (including its scalar direction) can be correctly represented in the reference system in *any* vectorial direction.

These facts are well understood. But it was not recognized, prior to the investigation whose results are being presented in this work, that the ability of a scalar motion to take anv direction in the context of a fixed spatial reference system is not limited to a constant direction.A discontinuous or non-uniform change of direction could be maintained only by repeated application offexternal forces, but once it is initiated, a continuous and uniform change of direction, such as that produced by rotation of the representation in the reference system, is just as permanent as a constant direction.

Aristotle and his contemporaries argued that a change of position of an object could be accomplished only by the application of some outside influence, and they provided an assortment of angels and demons for this purpose in formulating their physical theories. “A universe constructed on the mechanics of Aristotle,” says Butterfield, “was a universe in which unseen hands had to be in constant operation, and sublime Intelligences had to roll the planetary spheres around.”[1] By this time it is well understood that these conclusions of the Greek thinkers are erroneous, and that a continuous uniform change of position is just as fundamental and just as permanent as a fixed position. The essential requirement is the *continuity*. This principle is edually as applicable to direction as to position. Here, too, the essential requirement is simply continuity.

To illustrate a rotational change of direction of the representation of a scalar motion in a reference system, let us place the expanding balloon in the position previously defined in which point X rests on point A of the floor, and point Y coincides with point B of the reference system at time t. Then let us turn the balloon around point X (and A). Instead of continuing in the constant direction AB, the line XY representing the scalar magnitude now takes successive directions AC, AD, AE, etc., where C, D, and E, are points on the circumference of a circle centered on the axis passing through A. The total magnitude of the change of position, the distance moved by point Y outward from X in a given time interval, remains the same, but it has been distributed over all directions in the plane of rotation, instead of being confined to the one direction AB. The *motion* is unchanged; it still has the same positive magnitude, and no other property. But the *representation* of that magnitude in the reference system has been rotated. A further rotation of the original plane will distribute the representation in all directions.

In this illustration, the scalar motion XY of the balloon appears in the reference system as a distributed series of motions AB, AC, AD, etc. The common point is A; that is, by placing point X of the balloon on point A of the floor we have made A the reference point for the representation of the scalar motion XY in the fixed reference system. It can easily be seen that such a reference point is essential to the representation. We can therefore generalize this requirement, and say that in order to represent a scalar motion in a spatial coordinate system, it is necessary to give the motion, by means of a physical coupling to the reference system, both a reference point and a vectorial direction (which can be either constant or changing continuously and uniformly).

The significance of the reference point is that while this point is actually moving in the same manner as all other points in the scalar system of which it is a component, it is the one point of that system that is *not* moving relative to the fixed reference system. A distributed scalar motion is thus a quasi-permanent property of an object, even though the status of that object as the reference point for its scalar motion makes the object appear stationary in the coordinate system.

An important consequence is that since the scalar motion of the object alters the distance between this object and any other in the spatial reference system, the motion that is not represented by a change in the position of the moving object itself must be represented in the reference system by a change in the position of the other object. This conclusion that the motion of object X appears to observation as a motion of object Y appears strange, or even dubious, when it is encountered in a new situation such as the one now being discussed, but an apparent change of this kind always takes place when the reference system is altered. When traveling by train, for instance, and viewing another train moving slowly on the adjoining track, it is often difficult to determine immediately which train is actually in motion. In this case, if the moving train is mistakenly taken as stationary, its motion in the reference system is attributed to the other train.

In the present connection, the conclusion as stated can easily be verified by examination of the expanding balloon that is resting on the floor. Obviously, the true motion of spot X has not been changed by placing .this spot in a fixed position on the floor. The balloon expansion is still occurring in exactly the same way as before the placement, and spot X is therefore moving away from its neighbors. It follows that in the context of a fixed reference system, where X does not move, the scalar motion of spot X is distributed among the spots from which it is receding. For example, a part of the motion of spot Y, as seen in the fixed reference system, is actually a motion of spot X, the spot that occupies the reference point. The same is true of the motion of the distant galaxies. The recession that we measure is simply the increase in distance between our galaxy and the one that is receding from us. Unless we take the stand that our galaxy is the only stationary object in the universe, we have to concede that a part of this increase in distance that we attribute to recession of the other galaxy is actually due to motion of our own galaxy.

This is not difficult to understand when, as in the case of the galaxies, or the trains, the reason why the distant objects appear to move, or appear to move faster than they actually do, is obviously the arbitrary designation of our own location as stationary. What is now needed is a recognition that this is a general proposition. The same result follows whenever a moving object is arbitrarily taken to be stationary. As we have seen, the representation of a scalar motion in a fixed coordinate system requires the assignment of a reference point, a point at which the scalar motion takes a zero value in the context of the reference system. The motion that is taking place at that reference point is thus seen, *by the reference system*, in the same way in which we view our own motion in the galactic case; that is, the motion that is "frozen" by the reference system is seen as motion of the distant objects.

It should be understood, however, that this immobilization of the reference point in the reference system applies only to the representation of the *scalar* motion. There is nothing to prevent an object located at the reference point from acquiring an *additional* motion of a vectorial character. Where such motion exists, it is subject to the same considerations as any other vectorial motion.

The results of a directionally distributed scalar motion are totally different from those produced by a combination of vectorial motions in different directions. The magnitudes and directions of vectorial motions are interrelated, and their combined effects can be expressed as vectors. A vectorial motion AB added to a vectorial motion AB' of equal magnitude, but diametrically opposite direction, produces a zero resultant. Similarly, vectorial motions of equal magnitude outward in all directions from point A add up to zero. But the scalar motion XY of the spot Y on the balloon surface retains the same positive (outward) magnitude regardless of the manner in which it is directionally distributed. In this case, the direction is a property of the coupling to the reference system, not of the motion itself. The magnitude of the motion, and its scalar direction – outward–are unchanged regardless of the changes of direction as seen in the reference system.

Here, then, is one of the hitherto unrecognized facts that are being brought to light by this work, the existence of a type of motion that is quite different from the vectorial motions with which we are familiar.

This is a fact that is undeniable. We can *observe* this different type of motion directly in phenomena such as the expanding balloons, and we can detect it by means of measurements of radiation frequencies in the case of the receding galaxies. As can easily be seen, this motion has no property other than magnitude; that is, it is a scalar motion.

Referring again to the example of a motion of a point X between two points Y and Z, if this motion is vectorial, the *entire system* of three points and the motion can be placed in a fixed reference system as a complete unit. This is equally true if the system is large and multidimensional. But if the system YXZ is scalar, only *one point* in that system can coincide with a fixed point in the conventional stationary spatial reference system. The other two points are moving relative to the coordinate system. This is a very different kind of motion.

The status of scalar motion as a type of motion distinct from ordinary vectorial motion has not heretofore been recognized because the known phenomena involving such motion have not appeared to be of any appreciable consequence, and no one has undertaken to examine them critically. After all, there is not much interest in the physics of expanding balloons. But once it has been established that scalar motion is a distinct type of motion that can be originated by deliberate human action, it becomes evident that production of this type of motion by natural means is not only a possibility, but a definite probability. Indeed, we have already identified one naturally occurring motion of this kind, the galactic recession, and we are entitled to conclude that other natural scalar motions probably exist somewhere in the universe. Since no such motions are known at present, it follows that if they do exist, they are not currently recognized as motions. This further suggests that there must be some serious error in the current beliefs as to the nature of the phenomena in which these scalar motions are involved.

As soon as this issue is raised, it is practically obvious that the difficulty originates in the present attitude toward the concept offorce. 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, the relation of space to time, is measured on an individual mass unit basis as speed, or velocity, v, (that is, *each* unit moves at this speed) or on a collective basis as momentum, the product of mass and velocity, mv, formerly called by the more descriptive name "quantity of motion." The time rate of change of the magnitude of this motion is then dv/dt (acceleration, a) in the case of the individual unit, and m dv/dt (force, ma) when measured collectively. Thus force is, in effect, defined as the rate of change of the magnitude of the total motion. It can legitimately be called "quantity of acceleration,"and this term will be used in the following discussion where it is appropriate.

It follows from the definition that force is a *property ofa motion*; it is not something that can exist as an autonomous entity. It has the same standing as any other property. The so-called "fundamental forces of nature," the presumably autonomous forces that are currently being called upon to explain the origin of the basic physical phenomena, are necessarily properties of underlying motions; they *cannot* exist as independent entities. Every "fundamental force" must originate from a fundamental motion. This is a logical requirement of the definition of force, and it is true regardless of the physical theory in whose context the situation is viewed.

In the absence of an understanding of the nature and properties of distributed scalar motion, however, it has not been possible to reconcile what is known about the "fundamental forces" with the requirements of the definition of force, and as a result this definition has become one of the disregarded features of physics, so far as its application to the origin of the forces is concerned. Notwithstanding the fact that force is specifically defined as a property of motion, the prevailing tendency is to treat it as an autonomous entity, existing prior to motion. The following statements, taken from current physics literature, are typical:

So forces provide structure, motion, and change of structure.[2]
The gravitational force, the electric force, and the nuclear force govern all that happens in the world.[3]
The electric force is perhaps the fundamental conception of modern physics.[4]
As far as anyone knows at present, all events that take place in the universe are governed by four fundamental types of forces.[5]

It is commonly recognized that the usual significance attached to the concept of force is in some way incomplete. Richard Feynman's view is that force is something more than the defined quantity. "One of the most important characteristics of force is that it has a material origin," he says, and he emphasizes that "this is *not* just a definition." Further elaborating, he adds that "in dealing with force the tacit assumption is always made that the force is equal to zero unless some physical body is present."[6] This is unacceptable in an "exact" science. If a definition is incomplete, it should be completed. But, in reality, the definition is *not* incomplete. The prevailing impression that there is something missing is a consequence of the refusal to recognize that this definition makes force a property of motion.

The status of motion as the basic entity is the reason for the "material origin" that Feynman emphasizes. Without the presence of a "physical body" there is no effective motion, and consequently no force. The exact relation between the physical bodies and the motions of which the "fundamental forces" are properties will not be eonsidered in this work, as it involves some matters that are outside the scope of this present discussion.

The way in which force enters into physical activity, and its relation to motion can be seen by examination of some specific process. A good example is the action that takes place when a space vehicle is launched. Combustion of fuel imparts a rapid motion to the molecules of the combustion products. The objective of the ensuing process is then simply to transfer part of this motion to the rocket. From a qualitative standpoint, nothing more needs to be said. But in order to plan such an operation, a quantitative analysis is necessary, and for this purpose what is needed is some measure of the capability of the molecules to transfer motion, and a measure of the effect of the transfer in causing motion of the rocket. The property of force provides such a measure. It can be evaluated (as a pressure, force per unit area) independently of any knowledge of the individual molecular motions of which it is a property. Application of this magnitude to the mass that is to be moved then determines the acceleration of that mass, the rate at which speed is imparted to it. Throughout the process, the physically existing entity is motion. Force is merely a property of the original motion, the quantity of acceleration, by means of which we are able to calculate the acceleration per individual mass unit, a property of the consequent motion.

In the earlier paragraphs it was deduced that there exists, or at least may exist, somewhere in the universe, a class of distributed scalar motions, not currently recognized as motions. Now a critical examination of the concept of force shows that the presumably autonomous "fundamental forces" are properties of unrecognized underlying motions. These two findings can clearly be equated; that is, it can be concluded that the so-called "fundamental forces" are the force aspects of the hitherto unrecognized scalar motions. The reason for this lack of recognition in present-day practice is likewise practically self-evident. A scalar motion with a *fixed* direction is not currently distinguished from a vectorial motion, whereas if the scalar motion is *directionally distributed*, which is possible because of the nature of the coupling between the motion and the reference system, the phenomenon is not currently recognized as motion.

The distributed scalar motions have not been seen in their true light because "motion" has been taken to be synonymous with "vectorial motion," and phenomena such as gravitation that are effective in many, or all directions, and therefore have no specific vectorial direction, are clearly not vectorial motions. The concept of autonomous forces has therefore been invoked to provide an alternative. As brought out in the preceding discussion, it is not a legitimate alternative, since force is *defined* as a property of motion. This leaves present-day physical science in a dilemma, because it cannot identify the motions that the definition requires. An electric charge, for instance, produces an electric force, but so far as can be determined from observation, it does so directly. There is no indication of any intervening motion. This situation is currently being handled by ignoring the requirements of the definition of force, and treating the electric force as an autonomous entity generated in some unspecified way by the charge.

The need for an evasion of this kind is now eliminated by the clarification of the nature of scalar motion, which shows that the characteristics of rotationally distributed scalar motion are the very ones that are required in order to exert forces of the kind that are now erroneously regarded as autonomous. (t is now evident that the reason for the lack of any evidence of a motion intervening between the electric charge and the electric force is that *the charge itself is the motion*.It is the distributed scalar motion of which the electric force is a property.

The products of an analysis such as the foregoing do not come equipped with labels. A process of *identification* is therefore essential where, as in this present case, the analysis is based on premises of a general nature. Ordinarily the identification is easily accomplished, and in any event, it is self-verifying, as a wrong identification would quickly lead to contradictions. As an example of how this process operates, we observe certain objects in space that we call stars and planets. The nature of these objects is not apparent from the observations. At one time they were regarded as holes in the sky that allowed the light to shine through. But we have ascertained the properties of matter where we are in direct contact with it, and we have ascertained some of the properties of the stars and planets. To the extent that these properties can be compared, we find them to be identical. This justifies the conclusion that the stars and planets are aggregates of matter. In exactly the same way we identify the electric charge as a distributed scalar motion. It has the properties of a distributed scalar motion.

The identification of the other basic distributed scalar motions is carried out in the same manner. The details of this identification will be considered in the next chapter, but it is practically obvious that the most general form of rotationally distributed scalar motion can be identified as gravitation. In the light of the information developed in the preceding pages, it can be seen that the gravitational force is not the antecedent of the gravitational motion; it is a property of that motion. The continuous existence of the force is a result of the scalar character of the motion.

A uniform vectorial motion does not exert a force. By definition, a foree develops from such a motion only when there is a departure from uniformity; that is, when there is a change in momentum. However, the same well-understood geometrical considerations that lead to the inverse square relation in application to a force distributed over three dimensions likewise apply to a distributed scalar motion. If the total magnitude of such a motion is constant, the motion is *accelerated* in the context of a fixed reference system. The acceleration is positive for an inward motion and negative if the motion is outward. As noted by Wightman, since the days of Galileo it has been accepted that “whenever a body suffers an acceleration, there must be a force acting on it." [7] We now see that this is true only in the case of vectorial motion. A constant distributed scalar motion is an accelerated motion in the context of a fixed reference system, by reason of the geometry of that system. Once it is initiated, such a motion requires no outside force to maintain the acceleration.

The general nature of gravitation and other so-called "fundamental forces" is consistent with the foregoing conclusion, as they are distributed forces; that is, force fields. The force aspect of a vectorial motion is a vector; that of a distributed scalar motion is a field. The concept of the field originally evolved from the earlier concept of an ether, and to those who follow the original line of thinking a field is essentially an ether stripped of most of its physical properties. lt has the funetions of an ether, without the limitations. The ether concept envisioned a physical substance located in, and coextensive with, space. The school of thought generally identified with the name of Einstein has replaced this ether with a field that is located in and coextensive with space. "There is then no 'empty' space," Einstein asserts, "that is, there is no space without a field."[8] He concedes that from his viewpoint the change from ether to field is mainly semantic:

We shall say: our space has the physical property of transmitting waves, and so omit the use of a word (ether) we have decided to avoid.[9]

The greatest weakness of the ether concept, aside from the total lack of observational support, was the identification of the ether as a "substance." This established it as a physical connection between objects separated in space, and thereby provided an explanation for the transmission of physical effects, but it required the ether to have properties of an extraordinary and contradictory character. Calling this connecting medium a "field" instead of an "ether"eliminated the identification with "substance," without putting anything else in its place, and enabled the theorists to ascribe patterns of behavior to the medium without the limitations that necessarily accompany the use of a specificaily defined entity. Nevertheless, those who visualize the field as a purified ether still see it as "something physically real." Again quoting Einstein:

The electromagnetic field is, for the modern physicist, as real as the chair on which he sits.[10] We are constrained to imagine–after the manner of Faraday–that the magnet always calls into being something physically real in the space around it, that something being what we call a "magnetic field"… The effects of gravitation are also regarded in an analogous manner.[11]

Field theory is the orthodox doctrine in this area at present, but there is no general agreement on details. Even the question as to what constitutes a field is subject to considerable difference of opinion. For example, the following definition by Marshall Walker is a far cry from that expressed by Einstein:

A *field* is a region of space where a test object experiences its specific force.[12]

Here we see that the field is equated with space –"a field is a region of space"– whereas Einstein saw it as something real *in* the space. The difficulties in defining the field concept, together with others involved in its application, have raised many doubts as to the validity of current ideas. David Park gives us this assessment:

This does not mean that the ultimate explanation ofeverything is going to be in terms of fields, and indeed there are signs that the whole development of field theory may be nearer its end than its beginning.[13]

Clarification of the properties of scalar motion now shows that the present views as to the nature of a field are incorrect. A field is not a physical entity like the physicist's chair, nor is it a region of space. It is the force aspect of a distributed scalar motion, the quantity of acceleration, and it has the same relation to that motion as an ordinary force has to a vectorial motion. The two differ only in that the ordinary force has a specific direction whereas the force of the field, like the motion of which it is a property, is directionally distributed.

This is another olf the previously unrecognized facts of physical science that constitute the principal subject matter of this volume. It is not, like the *existence* of scalar motion, something that could have been recognized by anyone at any time, inasmuch as the discovery of distributed scalar motion was a prerequisite for recognition of the properties of that kind of motion. But as soon as the status of the "fundamental forces" as distributed scalar motions is recognized, the true nature of fields is clearly defined. And this answer that emerges from the scalar motion study isjust the kind of an explanation that the physicists have expected to find when and if the search for an answer was successful. Again quoting David Park:

At present, we imagine all space to be filled by a superposition of fields, each named after an elementary particle–electrons, protons, various kinds of mesons, etc. As new species proliferate, it becomes more and more desirable that future theory, if it resembles the present one at all, should contain but a single field, with the present types of matter corresponding to different modes of excitation of it.[14]

This is essentially what we now find. There is only one kind of field, a distributed force, but the nature of the effects produced by any specific force depends on the characteristics of the motion of which the distributed force is a property.

The finding that the fundamental forces are properties of fundamental motions rather than autonomous entities does not, in itself, solve the problem as to the origin offthese forces. In the case of gravitation, for instance, it merely replaces the question, What is the origin of the gravitational force? with the question, What is the origin of the gravitational motion? But it is a definite step in the right direction, and every such step brings us closer to the ultimate goal. A full-scale exploration of the problem has been carried out by the author, in the context of the theory of a universe of motion, and will be published in a series of volumes, the first of which, separately titled *Nothing But Motion*, is now in print.* This theoretical analysis, based as it is on a new concept of the fundamental nature of the universe, involves some significant alterations of existing physical viewpoints which not everyone will be prepared to accept. In order to make the results of the scalar motion study generally available, the presentation in this volume has been limited to those purely factual aspects of the scalar motion findings that are independent of theoretical considerations, and must be accommodated within every system of physical theory.

CHAPTER 2

Multi-Dimensional Motion

In the preceding chapter it was pointed out that scalar motion unquestionably exists (since we can observe it), but has not previously been recognized by physical science (because it has not heretofore been subjected to the kind of a critical analysis that would distinguish it clearly from ordinary vectorial motion). The long overdue study and analysis has now been carried out, and the results thereof are being described in this volume. So far it has been pointed out that scalar motion, which, by definition, has a magnitude, also has an inherent scalar direction (inward or outward, in the context of a fixed reference system), that it acquires a reference point and a vectorial direction when it is physically coupled to a reference system, that the acquired direction and reference point are totally dependent on the nature of the coupling, that this vectorial direction is not necessarily constant, but may be distributed over two or three dimensions of space, and that the distributed scalar motion is accelerated.

The most significant addition to scientific knowledge included in the foregoing list is the existence of rotationally distributed scalar motion. In this present chapter we will encounter another important addition to our store of factual information, another hitherto unrecognized physical fact, the existence of scalar motion in more than one dimension. This finding takes us farther out into the previously unexplored area of physical science. The distributed scalar motions are unique, and have no vectorial counterparts, but the ones that have been discussed thus far are specifically coupled to the reference system, and occupy identifiable positions in that system. Now we need to recognize that there are *other* scalar motions that *cannot* be represented in the reference system.

The finding that much of the action of the universe takes place outside (that is, independent of) the reference system which most individuals are accustomed to regard as the container, or setting, for all physical action, will no doubt be distasteful to many persons. Of course, it would be simpler and easier for the human individual who is trying to understand the physical universe if that universe would conform to the kind of a reference system that he finds convenient. But we have to face the fact that it does not do so. This was clearly established long ago, and is not seriously contested today in scientific circles. The questions still at issue are the nature of, and the reasons for, the discrepancies between the true physical situation and the representation in the reference system. The present-day “official” school of physical theory has found these questions so difficult to answer that it has, in desperation, resorted to the drastic step of abandoning physical reality, so far as the basic physical entities are concerned. According to Heisenberg, one of the principal architects of the prevailing structure of theory, the basic entities of the universe are not “objectively real” at all; they are phantoms which can “only be symbolized by partial differential equations in an abstract multidimensional space."[15] P.W. Bridgman, another distinguished physicist, retreats still further into philosophical obscurity, in this statement:

The revolution that now confronts us arises from the recent discovery of new facts, the only interpretation of which is that our conviction that nature is understandable and subject to law arose from the narrowness of our horizons, and that if we sufficiently extend our range we shall find that nature is intrinsically and in its elements neither understandable nor subject to law.[16]

Clarification of the nature of scalar motion, and identification of a number of the hitherto unexplained basic physical phenomena as motions of this kind makes the retreat from reality unnecessary. The mere fact that certain phenomena cannot be accommodated within the kind of a reference system we have chosen to utilize does not mean that they are unreal "phantoms." We cannot represent the whole of physical existence in terms of a reference system of limited scope, but by identifying the kinds of magnitudes that are not capable of representation in the system we can determine what additions or adjustments to the representation are required in order to arrive at an accurate description of the total physical situation.

This particular identification process is quite difficult, however, not because the process itself is particularly complicated, but because the reference system whose limitations we are trying to ascertain is the one to which our own physical activities conform, and to which, as a consequence, our thinking has been adjusted. In a sense, this undertaking is analogous to the proverbial task of lifting ourselves by our bootstraps. Even the simple concept of motion that is inherently scalar, and not merely a vectorial motion whose directional aspects are being disregarded, involves a conceptual reorientation of no small magnitude. Now we need to go a step farther and recognize that in a three-dimensional universe scalar motion is not limited to the one dimension that can be represented in the conventional spatial reference system. Two-dimensional or three-dimensional scalar motions are equally possible.

From a mathematical standpoint, an n-dimensional quantity is merely one that requires n magnitudes for a complete definition. As one dictionary explains, by way of illustration, "a^2-b^2-c is a term of five *dimensions*." A scalar motion in one dimension is defined in terms of one magnitude; a scalar motion in three dimensions is defined in terms of three magnitudes. *One* of the three dimensions of scalar motion can be further divided dimensionally by the introduction of *directions* relative to a three-dimensional spatial reference system. This expedient resolves the one-dimensional scalar magnitude into three orthogonally related submagnitudes, which, together with the directions, constitute *vectors*. No more than one of the three scalar magnitudes that define a three-dimensional scalar motion can be expressed vectorially, because the resolution of such a magnitude into vectorial components can only be accomplished in the context of a reference system, the capacity of which is limited.

This conventional reference system is three-dimensional in *space*, but it is not capable of representing more than one dimension of *motion*. Each individual motion that is represented is characterized by a vector, and the resultant of any number of motions of an object is a one-dimensional motion defined by the vector sum. All three dimensions of the reference system are required for the representation of one-dimensional motion of this nature, and there is no way in which the system can indicate a change of position in a second dimension. This limitation of the capabilities of the reference system does not restrict its ability to represent vectorial motion, inasmuch as that motion is, by definition, motion relative to the reference system, and it is therefore inherently one-dimensional. But we now need to recognize that scalar motion can take place in two or three dimensions, and that only *one* of these dimensions of motion can be represented in the reference system.

The existence of motion in more than one dimension is totally foreign to current physical thought, in which the entire physical universe, aside from such things as Heisenberg's "phantoms," and the "virtual particles" and other ghostly denizens of the quantum theories, is presumed to be contained within three-dimensional space and clock time. But this merely emphasizes the fact that the conventional reference system is not capable of representing the entire universe. Multi-dimensional scalar motion is not an assumption or a theory. It is a necessary consequence of the existence of the scalar type of motion, together with the existence of three dimensions of the universe. Each dimension is available for scalar motion.

In order to distinguish the dimensions of scalar *motion* from the dimensions of *space* in which one dimension of motion can take place, we will use the term "scalar dimension" in a manner analogous to the use of the term "scalar direction." Here, again, whatever semantic objections there may be to the terminology are more than offset by its convenience.

If the vector sum of all vectorial motions (measured as velocities) of an object is XA, this sum is represented by a line XA in the reference system. In this case XA is a *complete* representation of the motion. The representation of the scalar motion of some object *in the dimension of the reference system* may also be XA, but in this case XA is not necessarily a complete representation of the motion. For example, if the scalar motion is two-dimensional, the object that is moving from X toward A is also moving coincidentally in a scalar dimension XB perpendicular to XA. The motion XB is totally independent of XA, and cannot be combined with it to produce a resultant capable of representation in the reference system, as there is no way of combining independent scalar motions. They can be added. The scalar sum XA+ XB is a significant quantity for some purposes, but the motion XB does not enter into any of the physical phenomena that are related to position in the coordinate system.

The question naturally arises: If motion in a second or third scalar dimension has no effect that can be observed in terms of the spatial reference system, how do we know that such motion exists? For an answer it needs to be recognized that scalar speed is a p*hysical magnitude*. Under some circumstances, and within certain limits, this magnitude can be represented as a vector in a spatial coordinate system, as indicated in the previous pages. Beyond the scope of this representation it is still a physical magnitude, and it enters into any measurement of such magnitudes that *does not depend* on coordinate differences.

An example that will enter into some of the discussion that follows is the Doppler shift. This modification of the frequency of emitted radiation is a direct measurement of the speed of the emitting object, relative to the location of observation, and has no relation to the coordinates of the reference system. It therefore measures the total effective speed in the dimension of the reference system, irrespective of whether or not that total includes components in that same dimension that are not capable of representation in the reference system. The nature of such components will be considered later.

With the benefit of the foregoing information about the dimensions of scalar motion, we are now in a position to complete our identification of the principal distributed scalar motions that are responsible for the existence of the "fundamental forces." As noted earlier, it is quite evident that the characteristics of distributed scalar motion are identical with the observed characteristics of *gravitation*. In current thought, the gravitational rriotion is believed to be produced by an autonomous gravitational force of unknown origin. Einstein attributed it to a deformation of space due to the presence of mass, and his theory of gravitation, the general theory of relativity, is part of the dogma of modern physics. However, the extent to which it is actually accepted as a real explanation is indicated by the fact that practically every book or article about gravitation currently being published refers to it, either in the title or in the opening paragraphs, as a "mystery," a "purzle," or an "enigma." As described by Dean E. Wooldridge, "It is still as mysterious and inexplicable as it ever was."[17] R. H. Dicke, one of the leading investigators in this field, sums up the situation in this manner:

In any case, it appears clear that there is little reason for complacency regarding gravitation. It may well be the most fundamental and least understood of the interactions.[18]

The problem that has hitherto baffled those who have attempted to explain gravitation is that while it appears to be a force, its properties are totally unlike those of any ordinary force. So far as can be determined from observation, it acts instantaneously, without an intervening medium, and in such a manner that it cannot be screened off or modified in any way. These behavior characteristics are so difficult to explain on the basis of accepted physical theory that the theorists have taken the unprecedented step of repudiating the observations. Inasmuch as it has not been found possible to construct a theory that would fit the observations, these theorists have decreed that the observations must be modified to fit the theory. Accordingly, since they cannot explain the observed set of properties, they have constructed a fictitious set of properties that they *can* explain, and have substituted these fictitious properties for the observed properties. Notwithstanding all of the empirical evidence to the contrary, the current contention of the physicists is that the gravitational effect *must be* transmitted at a finite speed through a medium, or something with the properties of a medium.

There is no lack of recognition of the absurdity of the existing situation. The observers keep calling attention to the discrepancy between what they find and the assumptions on which current theory is based, as in this plaintive comment from a news item:

When it (the distance) is astronomical, the difficulty arises that the intermediaries need a measurable time to cross, while the forces in fact seem to appear instantaneously.[19]

The theorists admit that they have no factual support for their conclusions. As Max von Laue explains,

Nowadays we are also convinced that gravitation progresses with the speed of light. This conviction, however, does not stem from a new experiment or a new observation, it is a result solely of the theory of relativity.[20]

Meanwhile, voices are raised warning against this kind of defiance of the results of observation. This statement by G. deVaucoleurs is typical:

But if nature refuses to cooperate, or for a time remains silent, there is a serious danger that the constant repetition of what is in truth merely a set of a *priori* assumptions (however rational, plausible, or otherwise commendable) will in time become accepted dogma that the unwary may uncritically accept as an established fact or as an unescapable logical requirement.[21]

But all this falls mostly on deaf ears. When the scientific community fails to recognize the physical facts, such as the existence of distributed scalar motion, that point the way to *correct* explanations of certain phenomena, there is always a pressure on the theorists to produce *some kind* of an explanation. The inevitable result is the construction of erroneous theories, particularly at a time when the allowable latitude for the free use of ad hoc assumptions and other tactics for evading contradictions is as wide as it is today. As R. B. Lindsay describes the situation:

The clever physicist will always reserve the right to invent in arbitrary fashion the constructs he deems likely to succeed in the theoretical explanation of experience, even if this leads to rather bizarre devices for identifying these constructs with observational data.[22]

Once an erroneous theory is constructed with the aid of these "bizarre devices," and achieves general acceptance because "there is no alternative," it becomes part of the dogma of the scientific profession, and is defended against all attacks by all means available, the most effective of which is an ad hoc modification of the theory to meet whatever problem it encounters. As Einstein conceded,

It is often, perhaps even always, possible to adhere to a general theoretical foundation by securing the adaptation of the theory to the facts by means of artificial additional assumptions.[23]

In order to make these artificial assumptions plausible, it is often necessary to push some of the observed facts into the background where they can be ignored. This work is concerned primarily with previously unrecognized physical facts and their necessary consequences. There are, however, many other significant items of a factual nature that are known, but are disregarded, in part or in their entirety, because they conflict with some aspects of current physical thought. The term "neglected facts" was therefore used in the title of this volume in order to include those that are disregarded, as well as those that have not previously been identified. The observed properties of gravitation are in the disregarded category, although they are more than disregarded; they are totally repudiated.

If there ever was a legitimate excuse for this kind of open defiance of the results of observation, which is very doubtful, it has now been removed by the clarification of the nature of scalar motion, since it is evident that the properties of rotationally distributed scalar motion are identical with the observed properties of gravitation, those unidue properties that have baffled the investigators who have tried to deal with gravitation as an autonomous force. According to Feynman,

Newton . . . was satisfied to find *what* gravity did without getting into the machinery of it. *No one has since given any machinery*.[24]

Now we have the machinery. The key to an understanding of gravitation is a recognition that each gravitating object is pursuing its own course, independently of all others. A distributed scalar motion of such an object in the inward scalar direction is decreasing the magnitude of the distance between this object and every other object in the reference system. Inasmuch as this decrease is a result of the motion of the object itself, not of any interaction between objects, the decrease is instantaneous, and requires no medium. The reason for the observed inability to interpose any kind of a screen between gravitating objects is likewise evident.

These findings as to the nature of gravitation enable us to clarify the relation between gravitation and inertia, a subject about which there has been considerable confusion. The distributed scalar motion that we call gravitation has the same general properties as any other motion. The ones with which we are now concerned are a number of units (mass, m), a speed of each unit (v), a total quantity of motion (momentum, mv), an acceleration of each unit (dv/dt, or a), and a total quantity of acceleration (force, ma). Like any other distributed scalar motion, gravitation also has some special characteristics resulting from its scalar nature and its spatial distribution. One of these is that the magnitude of all of these properties, except the number of units involved, depends on the distance from the reference point. A related property is that because of the geometry of the reference system, the motion is accelerated. Both of these special characteristics have already been discussed.

Now we will want to take note of another unique property of distributed scalar motion. I nasmuch as an object with such a motion is arbitrarily assigned a speed of zero relative to the reference system by taking its location as a reference point for its scalar motion, it is possible to produce a compound motion, a motion of the distributed scalar motion, by moving the reference object. I n order to generate this motion, mv, a quantity of acceleration (or force), ma, must be applied. The mass appears in this process as a resistance to acceleration; that is, for a given applied force, the greater the mass the less the acceleration, on the individual unit basis. In gravitation, on the other hand, the mass appears to produce acceleration. It thus seemed to the early investigators in this area that there are two different quantities involved, an *inertial mass* and a *gravitational mass*. Very accurate measurements have demonstrated that the magnitudes of these two types of mass are identical. This naturally raised the question, Why? As reported by Gerholm:

This cannot be a coincidence! There must be some reason for the agreement. But within the framework of classical physics there is no explanation. When attention was directed to the problem, it seemed like a complete mystery.[25]

The “mystery” is simply a result of dealing with force on a basis that is inconsistent with its definition as a property of motion. If it is recognized that the physical processes with which we deal are relations between *motions*, and that what we are measuring are quantities of motion transferred from one condition to another, it is evident that the difference between output (as in gravitational action) and input (as in overcoming inertia) is in the nature of the process, not in the nature of the entities (motion and its properties) that are involved. This is well illustrated in cases where the same motion plays both roles. In a steam operated air compressor, for instance, the travel of the piston is the output of the first process, and the input of the second.

Einstein took a step forward in this area with his general theory of relativity. He did not quite bring himself to the point of recognizing that gravitation *is* a motion, but he formulated a principle of equivalence, in which he postulated (in the absence of any available means whereby he could draw the conclusion from established premises) that gravitation is *equivalent to* an accelerated frame of reference. This was a significant advance in understanding, and it enabled making some predictions of deviations from previous theory that have been verified, at least approximately, and have been impressive enough to secure general acceptance of the theory by the scientific community.

Notwithstanding its current status as the “official” gravitational theory, there is considerable dissatisfaction with it, particularly among the leading investigators in the gravitational area. Dicke’s characterization of gravitation, in the statement quoted earlier, as the “least understood of the interactions” is, by implication, an adverse judgment on the adeyuacy of the theory that is supposed to explain this phenomenon. Peter G. Bergmann observes that “lt appears as if general relativity contained within itself the seeds of its own conceptual destruction, because we can construct `preferred’ coordinate systems.”[26] Bryce DeWitt is more blunt. “Asa fundamental physical theory general relativity is a failure.”[27] he says.

The finding that gravitation is a distributed scalar motion explains why general relativity has not been able to satisfy the experts. While gravitation is accelerated, it is accelerated in a geometric manner cluite different from that of an “accelerated frame of reference.” Einstein’s assumption of an equivalence between the two therefore forced him to introduee a geometrical distortion in order to compensate for the partial error in the equivalence assumption. The arguments for so doing are usually difficult to follow because of the elaborate mathematical form in which they are normally presented, but a more readily understandable summary by Gerholm reads as follows:

If acceleration and gravitation are equivalent, we must apparently also be able to imagine an acceleration field, a field formed by inertial forces. lt is easy to realize that no matter how we try, we will never be able to get such a field to have the same shape as the gravitational field around the earth and other celestial bodies . . If we want to save the equivalence principle . . . if we want to retain the identity between gravitational and inertial mass, then *we are forced to give up Euclidean geometry*!Only be accepting a nonEuclidean metric will we be able to achieve a complete equivalence between the inertial field and the gravitational field. This is the price we must pay.[28]

An analysis of this statement in the light of the findings described in the preceding pages shows what is wrong with the current thought on the subject. Einstein's forward step in recognizing gravitation as the equivalent of an accelerated motion did not take him far enough to give him a clear picture of the situation. Before that clarification could be accomplished it was necessary to understand that gravitation is not only *equivalent to* an accelerated motion; it is an accelerated motion, but it is a motion of a special kind: a distributed scalar motion. The force aspect of such a motion is likewise directionally distributed: it is a force field. Accelerated *vectorial* motion of the gravitating object is *not* directionally distributed. One of the properties of such a motion is a quantity of acceleration, or force, but without the distribution in direction there is no force field. The notion, expressed in the foregoing quotation, that there is an inertial force field that has to be reconciled with the gravitational field by resort to non-Euclidean geometry is totally unfounded. The *mass* is the same in both cases, and the *total force* is the same, but the directional characteristics of the two types of motion are altogether different.

Just how much modification of general relativity will be required when the accelerated frame of reference is replaced by the correct distributed scalar motion is a question that is outside the scope of this present work. However, some points are quite clear. Those conclusions that result directly from the concept of gravitation as an accelerated motion (or the equivalent thereof), such as the gravitational redshift, will not be affected. Others, such as the advance of the perihelion of M ercury, will be seen in a somewhat different light.

There will be a return to Euclidean geometry, and no doubt, a corresponding simplification of the mathematics. The basic revision of Einstein's thought that will be required, however, results from the positive identification of gravitation as an *inherent property of matter*.

This was once the accepted explanation. Lovell reports,that "the idea of gravity as an intrinsic property of matter was gradually accepted and remained unchallenged until the publication of Einstein's general theory of relativity in 1916."[29] Einstein replaced this concept with his version of Mach's Principle, a hypothesis which asserts that "the inertial properties of matter on a small scale are determined by the behavior of matter on a cosmic scale."[30] This idea is simple enough in itself, but as Dennis Sciama explains:

To translate these ideas into complete mathematical form turns out to be a tricky business . . . The problem is technically difficult because Einstein's equations are non-linear. This means that the influence of many stars is not the simple sum of the influence of each one taken separately. It is, therefore, difficult to analyse the gravitational field of the universe in sufficient detail.[31]

Sciama reports that the uncertainties in this situation have occasioned many differences of opinion. There are, he says, three distinct schools of thought as to the direction that should be taken in further study. All of these ideas are now invalidated by the identification of gravitation as a distributed scalar motion. This identity, now a definitely established physical fact, carries with it the identity of gravitational and inertial mass, and invalidates Mach's Principle.

As noted earlier, identification of gravitation as a distributed scalar motion does not answer the basic question, the question as to its origin. This answer cannot be obtained from what we have learned thus far about scalar motion. Nor can this new information account for all of the details of the gravitational phenomenon. But the clarification of the nature of the gravitational effect is a significant accomplishment, and it opens the door to further advances. Such advances have already been made by means of investigations along theoretical lines, and are reported elsewhere. They will not be discussed here, as this volume is being limited to the findings with respect to scalar motion, and their direct consequences, items that are independent of the changes in basic physical concepts that are involved in the theoretical development.

When the status of gravitation as a distributed scalar motion is recognized, it is only one more step to a realization that the presumably autonomous electric and magnetic forces are also properties of distributed scalar motions. “No one,” says Feynman, “has ever succeeded in making electricity and gravity different aspects of the same thing.”[32] This statement is now outdated. Like gravitation, the electric charge, the source of the electric force, is a *motion*. This finding will no doubt come as a surprise to most scientists, and there may be a tendency to regard it as a drastic revision of current scientific thought. But current science has nothing at all to say on the subject. The charge is simply accepted as a given feature of the universe, an “unanalyzable,” as Bridgman called it. We are told that it makes no sense to ask what the charge is. Andrade elaborates on this point in the statement quoted in part in Chapter 1:

The question, “What is electricity’?”–so often asked –is . . . meaningless . . . Electricity is one of the fundamental conceptions of physics; it is absurd to expect to be told that it is a kind of a liquid, or a known kind of force, when we explain the properties of liquids in terms of electricity, and electric force is perhaps the fundamental conception of modern physics.[4]

This statement, which purports to explain why the question is unanswerable, actually explains why the physicists are unable to answer it. They are putting the cart before the horse. By ignoring their own definition of force, and elevating electric force to the status of a “fundamental conception” they are closing the door on any recognition of the antecedents of that force.

Those who concede any meaning at all to the question as to the nature of electric phenomena generally consign such yuestions to the metaphysical realm, as in this statement by F. N. H. Robinson:

The question “What is electricity?” like the question “What is matter?” really lies outside the realm of physics and belongs to that of metaphysics.[33]

This line of demarcation between the physical and the metaphysical that is drawn in current thought is actually a boundary between that which is believed to be understood and that which is not understood. A force originates in some way from an electric charge. Force is a phenomenon with which the physicists consider themselves reasonably familiar. Charge is something that they have never been able to bring within their field of comprehension. Mass, the property of matter that determines the magnitude of the gravitational force, is no better understood. Magnetism is explained as being due to the motion of charges, but as long as the charges remain unexplained, the addition of movement does not represent much of an advance in understanding. The physicists have therefore taken force, the phenomenon that they believe they do understand, as the basic physical reality.

As pointed out in Chapter 1, this promotion of force to the status of an autonomous basic physical entity is self contradictory, since force is *defined* in a way that makes it a property of a motion, not an independent entity. The autonomous force concept has survived only because no satisfactory alternative has heretofore been available, and without something to take its place, the physicists have been unwilling to subject it to the kind of a critical examination that strict adherence to scientific procedure would require.

Recognition of the existence of distributed scalar motion has now clarified the situation. The "fundamental forces" are the force aspects of distributed scalar motions. "Charge" and "mass" are merely names for these previously unrecognized motions. There is no need to resort to metaphysics to account for their existence.

Like the gravitational motion, the electric and magnetic motions are distributed over the three spatial dimensions of the reference system, and they have some of the same general characteristics. But there are also some significant differences. One of these is that the electric force is vastly more powerful than gravitation. Science writers are fond of pointing out that gravitation would be a relatively inconsequential feature of the universe if it were not for the immense size of so many of the objects from which it originates: stars, planets, galaxies, etc.

The finding that scalar motion can take place in three scalar dimensions, only one of which is capable of representation in the spatial reference system, now supplies an explanation of this difference in magnitude. We can logically conclude that gravitation, which is clearly the basic type of distributed scalar motion, applying to all material objects under all conditions, is the motion that takes place in all three scalar dimensions. The difference in the magnitudes of the motions, as observed in the reference system, can then be readily accounted for if we identify the electric motion as being limited to one scalar dimension. On this basis, the full magnitude of the electric motion (and force) is effective in observable physical phenomena, whereas only one dimension of the three-(scalar) dimensional gravitational motion (and force) is similarly effective.

A logical corollary of the foregoing is the existence of a two(scalar) dimensional motion (and force) of the same nature, with a magnitude intermediate between that of gravitation and that of the electric motion. Magnetism is a phenomenon that clearly meets this specification. Here one dimension of motion is observable in the reference system, and one is unobservable. These comments apply only to what is known as "permanent magnetism" and to the phenomena of "magnetostatics." Electromagnetism is a phenomenon of a different nature that is outside the scope of this present work.

The quantititive relations are in general agreement with the foregoing qualitative observations. The numerical relation between space and time in one dimension, as indicated by the speed of light (the significance of which we will discuss later), is 3×10^{10}

in terms of conventional measurement units (cgs system). According to the foregoing explanation, it is $(3 \times 10^{10})^2$ in magnetism. The normal relation between electric and magnetic quantities should therefore be 3×10^{10}, which agrees with the observed value. The relation betwen the electric and gravitational motion is affected by some differences in the nature of the motion distribution that will be examined in Chapter 3, but the ratio of electric to gravitational force is substantially greater than the electric/ magnetic ratio, as the dimensional difference requires.

This identification cf electric and magnetic forces as the force aspects of distributed scalar motions conflicts in some important respects with currently accepted ideas. Inasmuch as the current ideas are products of the prevailing *theory* of electricity and magnetism, there will no doubt be a tendency to take it for granted that the new conclusions reached herein are products of some *different theory*. This is not correct. The identification is purely *factual*. We define certain classes of entities and determine their properties from observation. When we then observe entities that have these properties, and no others that are inconsistent with them, we identify these observed entities as members of the defined classes. This is a purely objective and factual process. The results thereof have the same standing as any other items of factual knowledge.

It follows that those elements of the currently prevailing theory that arrive at different conclusions are definitely in error, in whole or in part. This is not a matter of opinion orjudgment. When one tenable theory conflicts with another, a decision as to which is correct, or more nearly correct, generally has to depend, to a considerable degree, on judgment as to the weight to be accorded to each of the various items of evidence. But when a theory conflicts with definitely established facts, it is no longer tenable, and it must give way.

Once the existence of these distributed scalar motions is recognized, it is immediately evident that the basic error in current theory is the assumption that electric, magnetic, and gravitational effects are propagated at a finite speed through a medium, or something with the properties of a medium. As noted earlier, the observed characteristics of gravitation are in direct conflict with this assumption, and the physicists can maintain their theoretical position only by repudiating the observations. The situation with respect to the electric and magnetic forces is not as clear-cut, as it is confused by the existence of other related phenomena that are not distinguished, or not clearly distinguished, from the effects of these forces in current thought. The most significant contributor to the existing confusion is electromagnetic radiation.

No detailed discussion of this radiation will be included in this present volume, as it does not enter into the matters here being discussed. However, since current theory is based on the assumption that radiation is involved in these matters, it will be advisable to point out just what is wrong with this hypothesis. Radiation is an *energy transmission process*. Photons leave the radiation source, travel through space, and eventually reach a material atom or aggregate by which they are absorbed. Each photon carries a specific amount of energy. The energy of the source is decreased by this amount when the photon is emitted, and tne energy of the absorber is increased by this amount when the photon is absorbed. At either end of the path the radiant energy is readily interchangeable with any other type of energy. The energy of the impinging photon may, for instance, be converted into kinetic energy (heat), or into etectric energy (the photoelectric effect), or into chemical energy (photo-chemical action). Similarly, any of these other types of energy that may exist at the point of emission of the radiation may be converted into radiation by appropriate processes. This radiant energy transmission process is entirely independent of the distance between the emitter and the absorber, aside from the effect of the distance on the amount of time required for the travel.

The action of a distributed scalar motion is a totally different kind of a process. Gravitation, for instance, instead of being independent of the distance, is totally dependent on the distance; that is, the separation between the objects under consideration. Unless this distance is altered, there is no change at all in the energy of either object. The *force* persists, but there is no energy effect. Where one object does increase its kinetic energy by reason of a decrease in the distance, as in the case of an object falling toward the earth, this energy increment is not acquired at the expense of the earth; it is derived from the energy of position (the potential energy) of the moving object itself.

Furthermore, gravitational energy is not interchangeable with other forms of energy. At any specific location with respect to other masses, a mass unit possesses a definite amount of gravitational (potential) energy, and it is impossible to increase or decrease this energy content by conversion from or to other forms of energy. It is true that a change of location results in a release or absorption of energy, but the gravitational energy that a mass possesses at point A cannot be converted to any other type of energy at point A, nor can the gravitational energy at A be transferred unchanged to any other point B (except along equipotential lines). The only energy that makes its appearance in any other form at point B is that portion of the gravitational energy which the mass possessed at point A, but can no longer retain at point B: a fixed amount determined entirely by the difference in location.

These facts are obvious to anyone who wants to see them, but as Harlow Shapley once remarked in a comment about the situation in the cosmological field, facts have been the number one enemy of theories.[34] After the theorists have found themselves frustrated time and time agáin over a long period of years they become desperate, and begin constructing their theories in defiance of the facts. This is what has happened in the areas that we are now examining. Thus it is not surprising that these current theories are in conflict with the new facts disclosed by the scalar motion investigation. They were already in conflict with many *old* facts that have long been part of the main body of scientific knowledge. In the terminology of this work, these are disregarded facts.

CHAPTER 3

Distinctive Properties

It is difficult to reconcile the general acceptance of the current theories discussed in the preceding chapter with the respect that science claims to accord to the observed facts. As expressed by Max Black, "If one trait, more than any other, is characteristic of the scientific attitude, it is reliance on the data of experience.[35]But in the formulation of these theories the data of experience are summarily rejected. Apparently the prevailing opinion is that any theory is better than none at all. Of course, there is something to be said for this proposition if the wrong or untestable theories are accepted only on an interim basis, as something to be .used pending the discovery of the correct relations. However, such an interim acceptance is not proof, or even evidence, of the validity of a theory, and it certainly provides no justification for repudiating or disregarding the physical facts.

Elevation of a currently popular theory to a status superior to established facts, as indicated in the quotation from Max von Laue, is a violation of the most basic tenets of science. Whatever the standing of the relativity theory as a whole may be, if and when it conflicts with a physical fact it is, to that extent, wrong. No scientist can deny this if he faces the issue squarely. But to acknowledge such errors would involve conceding that there are serious deficiencies in the conventional structure of theory, and this the scientific community is currently unwilling to do.

At the moment science is riding the crest of a remarkable record of achievement unparalleled elsewhere in human life, and this has fostered an overconfidence in the procedures and capabilities of the scientific profession, specifically the widely held belief that what present-day scientists have not been able to do cannot be done. If long and careful consideration by competent scientists has not succeeded in finding a viable alternative to an accepted theory that is inconsistent with some physical fact or facts, then it is evident, from the present viewpoint of the scientific Establishment, that no such alternative exists. We must accept the defective theory or concept because we have no choice. "There is no other way,"[36] says Einstein. "There was and there is now no alternative,"[37] asserts Millikan. "There are no physical laws to tell us - and there cannot be,"[38] contends Bronowski. Bridgman refers to the "only interpretation" [16] of the facts that he cites, and so on. This assumption of omniscience is all the more difficult to understand in view of the clarity with which each generation of scientists recognizes the limitations to which *their predecessors* were subject. As expressed by Millikan:

We all began to see that the nineteenth century physicists had taken themselves a little too seriously, that we had not come quite as near sounding the depths of the universe, even in the matter of fundamental physical principles, as we thought we had.[39]

The nature of the fallacy that is inherent in all statements of the "There is no other way" type is well illustrated by the situation to which Einstein applied these words. He was referring to his "rubber yardstick" for space and time. "Moving rods must change their length, moving clocks must change their rhythm," [36] is his conclusion. The positive assertion by R. A. Millikan that "there is no alternative" refers to the same conclusion. But like the former generations of scientists to whom Millikan refers in the longer quotation, he and Einstein are basing their conclusions on the premise that the prevailing view of physical fundamentals is incontestable. As Fred Hoyle pointed out in connection with a similar conclusion in a different field,

The argument amounts to nothing more than the convenient supposition that something which has not been observed does not exist. It predicates that we know everything.[40]

The truth is that we can never be certain that all alternatives to a set of premises have been identified, or even that we have correctly identified all of the elements that enter into any given situation. The findings with respect to the properties of scalar motion that are reported in this volume now show not only that Einstein was incorrect in his assertion that “there is no other way,” but that the “only way” that he was able to see is the wrong alternative. As noted by one observer, “In his relativity theory, he (Einstein) quite rightly started with the commonplace assumption that time is what you read off a clock.”[41]This “assumption” is actually a definition of time for purposes of Einstein’s development of thought, and no exception can be taken to it on that basis. But after thus defining it, he turned around and *assumed* that “time” , as thus defined, is also the “time” that enters into the equations of motion. There is no physical evidence that this is true, as a general proposition. At low speeds there is agreement, and if this agreement applied throughout all motion, the identity of the two concepts of “time” would be verified by the same principles of identification that were discussed earlier in this work. But there is no such agreement at high speeds.

The conclusion that would normally be reached from such a discrepancy is that “time” as identified by a clock registration *cannot* be identified with the “time” that enters into the equations of motion. In the analogous case of the identification of the stars and planets, discussed in
Chapter 1 , if the properties of these objects, under some conditions, were found to be quite different from those of matter, then the identification as aggregates of matter would no longer be tenable. But Einstein did not accept the verdict of the observations, and instead of recognizing that they invalidated the assumption as to the identity of the two concepts of “time,” he assumed a variability in the *magnitudes* that are involved.

In the subsequent pages of this work the nature of the “time”that enters into the equations of motion will be determined from factual premises, and it will be shown that it is *not*, except in a special case, equivalent to the “time” registered on a clock - the same conclusion that would normally be drawn from the discrepancy that has been mentioned. The mere appearance of this conclusion, regardless of how it was derived. and independent of its validity, automatically demolishes the contention of Einstein, Millikan, and the scientific community in general, that “there is no other way,” as it clears the way for an explanation based on a different concept of time.

The true place of time in the physical picture will be considered later. The point of the present discussion is that the theories and concepts of present-day physical science are not all firmly established and incontestable, as the textbooks would have us believe. Many of them are, to be sure, but others are nothing more than temporary expedients - steppingstones toward better theories,[42]as P. A. M. Dirac called them. Norwood Hanson explains that we are accepting theories that are “conceptually imperfect” and “riddled with inconsistencies” because there is no “intelligible alternative” currently available.[43]In those cases, such as the gravitational situation discussed in the preceding chapter where the new findings from the scalar motion investigation take issue with current thought, they are merely producing the “intelligible alternative” or “other way” that is required to put physical understanding on a sound basis. In this present chapter we will continue this operation, exploring the consequences of the distinctive properties of scalar motion.

One of the unique characteristics of this type of motion is that it is indifferent to *location* in the spatial reference system. From the vectorial standpoint locations are very significant. A vectorial motion originating at location A and proceeding in the direction AB is specifically defined in the reference system, and is sharply distinguished from a similar motion originating at location B and proceeding in the direction BA. But since a scalar motion has magnitude only, a scalar motion of A toward B is simply a decrease in the distance between A and B. As such, it cannot be distinguished from a motion of B toward A. Both of these motions have the same magnitude, and neither has any other property.

Of course, the scalar motion *plus* the coupling to the reference system does have a specific location in that system: a specific reference point and a specific direction. But the coupling is independent of the motion. The factors that determine its nature are not necessarily constant, and the rnotion AB does not necessarily continue on the AB basis. A change in the coupling may convert it to BA, or it may alternate between the two.

The observed deflection of photons of radiation toward massive objects is an illustration of the application of this property of scalar motion. The photon has no mass, and therefore no gravitational motion toward a massive aggregate, a star, for instance. But the gravitational motion of the star is a distributed scalar motion, and this scalar motion of the star toward the photon (AB) is inherently nothing more than a decrease in the distance between the objects. It can equally well appear in the reference system as a motion of the photon toward the star (BA). On the basis of probability, the total motion is divided between the two alternatives. The total motion of the star toward the photon is distributed among so many mass units that the motion of each is unobservable, but the photon is a single unit, and it is deflected a small, but measurable, amount toward the star.

Another manifestation of this property of scalar motion is seen in the *induction* of electric charges. As brought out in Chapter 2, the electric force is a property of a distributed scalar motion. “Charge” is therefore merely a name for this entity that has not heretofore been recognized as a motion. While charges are generally similar to the gravitational motion, aside from the difference in dimensions, it is clear from their effects that their distribution does not have the constant rotational pattern that is characteristic of gravitation. Instead, the rotation of the coupling to the reference system changes constantly and uniformly from clockwise to counterclockwise, and vice versa: that is, it is a simple harmonic motion. The pattern of this distribution is a rotational vibration, similar to the motion of the hairspring of a watch, rather than a simple rotation.

A consideration of the factors involved in the addition of scalar motions shows that this distinetive characteristic of the distribution of the electric motion is a positive requirement. It is necessary for the existence of this type of motion. If the charge had a full rotational distribution, differing from gravitation only by reason of being onedimensional, it would merely modify the magnitude of the gravitational motion in this one dimension, and would not constitute a distinet physical phenomenon. But the rotational vibration is a different kind of a scalar motion, and it *adds* to the gravitational motion rather than *merging with* it.

The vibratory nature of the electric motion (charge) favors a periodic redetermination of the direction of motion (that is, a change in the nature of the coupling of the scalar motion to the reference system). As in the photon situation, the result is a distribution of the motion between the two alternatives. In each case, the motion that originated as AB becomes divided between AB and BA. The result is more striking in the case of the electric charge because of the vibratory nature of the motion, which makes it evident that the motion of object B is *induced* by the similar motion of the initially charged object A.

Corresponding to the one-dimensional scalar motion distributed in a rotational vibration pattern that we know as the electric charge is a two-dimensional scalar motion similarly distributed. As noted in Chapter 2, this is a *magnetic* motion. The term “charge” is not generally used in relation to magnetism, because present-day theory regards magnetism as due to motion of electric charges, rather than as a distinet phenomenon. On the basis of aur findings with respect to distributed scalar motion, however, it is evident that there is a magnetic scalar motion similar in all (or at least most) respects to the electric charge, except that it is two-dimensional. A detailed development of the magnetic situation will require a theoretical base, which is something that is not provided by the factual treatment of scalar motion in this volume, but it can be deduced from what is known about the analogous electric charge that permanent magnetism and magnetostatic phenomena are two-dimensional distributed scalar motions (and their consequences), whereas electromagnetism is something of a different character.

The foregoing explanation of the fundamental nature of electric and magnetic action has the appearance of action at a distance, a concept that is philosophically objectionable to many scientists. Because of this philosophical bias, the prevailing opinion is that there *must* be some kind of transmission of an effect between the inducing object and the object in which the effect is induced, notwithstanding the total lack of any physical evidence to support this conclusion. But action at a distance is a concept that does not apply to scalar motion at all. An outward scalar motion of object X simply increases the distance between X and all other objects. So far as the relation between X and some other object Y is concerned, this result is indistinguishable from an outward scalar motion of Y. Because there is no difference between the scalar motion XY and the scalar motion YX, the representation of this motion in the reference system can take either form (or alternate between the two), even though, from the standpoint of the *reference system*, XY and YX are two distinct motions.

There is nothing strange or irrational about this as long as it is understood that we cannot expect the universe to conform to the particular arbitrary pattern that happens to be convenient for us. The problems arise when we attribute reality to these arbitrary patterns. The fact that will have to be faced is that the three-dimensional fixed spatial framework in which we customarily view the universe is not a container or background for physical activity, as has been assumed. It is merely a refererice system. What the scalar motion investigation has disclosed is that it is a very imperfect reference system. As we saw in Chapter 2, it is limited to one of the three dimensions in which scalar motion takes place. Chapter 4 will show that it is further limited to a fraction of the total range of scalar speeds. The point now being emphasized is that even within the limited regions in which it is capable of representing scalar, as well as vectorial, motion, there are some aspects of scalar motion that are incompatible with the *inherent nature* of a fixed reference system.

To most scientists, this is an unwelcome conclusion. But it is a direct consequence of established physical facts, and it is therefore true regardless of how unpopular it may be. Furthermore, it has long been recognized that there is *something* wrong with the naive assumption that nature will obligingly accommodate itself to the kind of a reference system that we find most convenient, and it has further been recognized that, as a consequence, we are faced with the necessity of making some changes of a drastic, and probably distasteful, nature in our views as to the relation between physical reality and the representation of that reality in the conventional reference system. For example, F. A. Lindemann made this comment fifty years ago:

It is not easy to make clear the arbitrary nature of the space-time framework which we have chosen in order to describe reality. The coordinates are so convenient in the case of the grosser macroscopic phenomena, immediately perceptible to our senses, and have become so deeply ingrained in our habits of thought and so inextricably embalmed in our language that the suggestion that these indefinables may be meaningless, or, at the best, only statistically valid, is bound to be met with a certain amount of repugnance.[44]

Enough is now known about this situation to make it clear that the question is not *whether* there are aspects of reality that are not correctly represented in the conventionat spatial reference system, but rather, What is the nature of the deviations? As matters now stand, most of the items of this character with which we will be concerned in the pages that follow are still unexplained by present-day science. Einstein's relativity theory is currently credited with having provided the explanation of what originalty appeared to be a deviation of this kind, an apparentty irreconcilable conflict between representation in the reference system and direct speed measurement at very high speeds. In both this and the gravitational situation, Einstein's answer was to *distort the reference system*, investing the space and time of that system with enough flexibility to conform with the mathematical expression of the observed behavior. He admitted that "it is not so easy to free aneself from the idea that co-ordinates must have an immediate metrical meaning,"[45]but as he saw the problem, and asserted in the statement previously quoted, "there is no other way."

Recognition of the existence of scalar motion, and the consequences of that existence, has now produced the allegedly nonexistent "other way" in both of these cases, eliminating the need for any distortion of the reference system, and identifying both gravitation and high-speed motion as normal phenomena of the region represented in the reference system. However, there are also many real deviations of the natural order of the universe from the conceptual structure represented by the conventional three-dimensional spatial frame of reference, and these constitute the principal subject matter of this present volume. The apparent action at a distance resulting from the indifference of scalar motion to location in the reference system is merely one of the ways in which the reality of physical existence deviates from the simple and convenient framework in which the human race has attempted to confine it.

In this case, the problem arises because all elements of a scalar motion system are moving. In order to place this system in a fixed frame of reference, one of these elements must be arbitrarily designated as stationary, but there is no requirement that this assignment be permanent. In the scalar interpretation of the threepoint system YXZ, for instance, all three points are moving away from each other. While point X is moving in the direction XY, it is also moving in the direction XZ. There is no way in which this kind of motion can be represented in a fixed reference system in its true character. When the motion is brought into the reference system it is coupled to that system in such a way that some point that is actually moving becomes stationary relative to the coordinate system. lf this point is X, the motion of Y outward from X becomes an observable motion in the reference system, while the motion of X outward from Y becomes unobservable, because X is motionless *in the reference system*. The distinction between stationary and moving, which is essential for representation in the reference system, but does not exist in the motion itself, is provided by the physical coupling of the motion to the reference system.

I nasmuch as the coupling is separate and distinct from the motion - the placement of the expanding balloon in the room, for example, is completely independent of the expansion of the balloon - there is no reason why it must necessarily retain its original form permanently. On the contrary, it is to be expected that in the normal course of events, particularly where the nature of the coupling is determined by probability factors, there will be a redetermination from time to time. This is what happens in the induction of charges.

In the induction process, the unusual effect arises because the reference system has a property, location, that the scalar motion does not have. Another unusual effect arises for the inverse reason: the scalar motion has a property that the reference system does not have, the property that we have called scalar direction. The spatial reference system does not distinguish specifically between inward and outward scalar motion. For instance, an object falling toward the earth by reason of gravitation is moving inward. Light photons reflected from this object, which may be moving on exactly the same path, are moving outward. In the context of the spatial reference system, however, both the light beam and the object are moving from the original location of the object toward the earth. In this case an outward (positive) scalar magnitude and an inward (negative) scalar magnitude are represented in the spatial reference system in exactly the same manner.

This is another place where the reference system is not capable of representing scalar motion in its true character. H owever, we can take care of this situation conceptually by introducing the idea of positive and negative reference points. As we saw earlier, assignment of a reference point is essential for the representation of a scalar motion in the spatial reference system. This reference point then constitutes the zero point for the measurement of the motion. It will be either a positive or a negative reference point, depending on the nature of the motion. The photon originates at a negative reference point and moves outward toward more positive values. The gravitational motion originates at a positive reference point and moves inward toward more negative values. If both motions originate at the same location in the reference system, as in the case of the falling object, the representation of both motions takes the same form in this system.

What we are doing by using positive and negative reference points is compensating for a deficiency in the reference system by the use of an auxiliary device. This is not a novel expedient; it is standard practice. Rotational motion, for instance, is represented in the spatial reference system with the aid of an auxiliary quantity: the number of revolutions.

Similarly, a clock is an auxiliary device without which the reference system could portray only spatial quantities, and could not show motion at all. Scalar motion is no different from vectorial motion in its need for such auxiliary quantities, except that it has a broader scope, and as a result transcends the reference system in more ways.

Aside from clarifying the theoretical situation, this recognition of two kinds of reference points has little effect in dealing with gravitation or radiation, as both of these phenomena maintain the same reference point and the same scalar direction within the range capable of representation in the conventional spatial reference system. But there are other phenomena that involve both reference points. For example, the motion that constitutes an electric charge, a distributed scalar motion, is always outward, but that of a positive charge is outward from a positive reference point, while that of a negative charge is outward from a negative reference point. Thus, as indicated in the accompanying diagram, while two positive charges (line a) move outward away from each other, and two negative charges (c) do likewise, a positive charge moving outward from a positive reference point, as in (b), is moving *toward* a negative charge that is moving outward from a negative reference point. Thus like charges repel each other, while unlike charges attract.

```
                  –            +            –            +
(a)               |        <——|——>          |
(b)                            |——>     <——|
(c)                            |        <——|——>          |
```

The special characteristics of the electric and magnetic motions, the vacant dimensions, the inductive effects, and the alternate reference points, account for the screening effects that are prominent features of electricity and magnetism, but are absent in gravitation. As can be seen from the nature of distributed scalar motion, the motion of A toward or away from B, and the corresponding force, cannot be affected by anything in the space *between* A and B, unless that entity is in contact with either A or B. But if the intervening object C has a distributed scalar motion of the same kind, then the total effect is A + C. In the case of gravitation, C is always positive, as gravitation is always inward, and, in our local environment, always has a positive reference point. In electrical and magnetic phenomena, however, the charge on C, if any, can be either positive or negative. lt is usually an induced charge, and therefore opposes the charge on A. In this case C is a negative quantity, and the net charge A + C is less than A; that is, there is a screening effect.

Any one dimension of a multi-dimensional scalar motion can be represented in the spatial reference system. As indicated earlier, if the scalar motion XA is thus represented, any motion XB that may exist in a second scalar dimension has no observable effect in the reference system. However, under some circumstances, a scalar motion AX, equal in magnitude to the motion XA, and opposite in scalar direction, may be superimposed on XA, reducing the net effective motion in this dimension to zero. In this case there is no obstacle to representation of motion in another dimension, and the motion XB therefore makes its appearance in the reference system. Thus the rather unusual result of applying the negative motion (or force) is to produce a motion perpendicular to the direction of the originating motion.

According to Newton's Second Law of Motion, the acceleration is in the direction of the applied force. The effectjust described appears to violate this law, and in view of the firm position that the second law occupies in physics, a violation is admittedly hard to accept. But, as can be seen by an examination of magnetic phenomena, the kind of an effect that has been described actually does occur. Conventional physics has no explanation for it. The perpendicular direction of the resultant is merely dismissed as a "strange" effect. From the explanation in the preceding paragraph it can be seen that the second law is not actually violated. The applied force does act in accordance with this law, producing an acceleration in the direction of the force, but that acceleration counterbalances an oppositely directed gravitational motion in the dimension of the applied force, reducing the net speed in that dimension to zero. This allows the gravitational motion in a perpendicular dimension, normally unobservable, to manifest itself in the reference system.

Here is one of the places where it is necessary to recognize that scalar motion has special characteristics of its own, and cannot be fully accommodated within the narrower limits of the rules that apply to vectorial motion. This may be a difficult idea for those who have grown up under the shadow of conventional scientific thought, but whatever mental anguish this and the other necessary readjustments of thinking may cause is a small price to pay for all of the clarification of ihe physical picture that is aecomplished by recognition of the existence and properties of scalar motion.

As indicated in the introductory comments in Chapter I, the presentation in this volume, which deals entirely with established facts and their necessary consequences, is independent of the physical theory in whose context the phenomena involving scalar motion are viewed. This type of motion unquestionably exists, but its role in physical activity has not heretofore been subjected to a critical examination. The objective of this volume is to fill this vacuum; to provide the basic information about scalar motion that is part of the empirical knowledge of the universe around which any theory must be constructed.

What the discussion thus far has done is to explore the consequences of recognizing that the so-called "fundamental forces" of physics are, in fact, distributed scalar motions, and to identify the modifications of current physical thought that are required by reason of this correction of a canceptual mistake. The effect of these modifications is largely explanatory rather than substantive. The treatment of gravitation in practical application, for instance, remains essentially unchanged. But its physical properties are now fully accounted for, and there is no longer any need to call upon ad hoc assumptions, such as the assumption of a finite speed of propagation, that are contrary to observed fact, or, like the assumption that space has the properties of a medium, are conceptually unsupportable. In other cases, the result has simply been to provide an explanation for something that has heretofore been unexplained, or has been regarded as unexplainable. The electric charge, for example, no longer has to be accepted as a given feature of the universe that is incapable of explanation in terms of more fundamental concepts. The perennial question, What is an electric charge?, no longer has to be dismissed as unanswerable. We can now reply that an electric charge is a onedimensional distributed scalar motion.

Although some of the hitherto unknown physical phenomena discussed in the preceding pages, such as scalar motion in the second and third dimensions, are unobservable, they are, at least in a sense, within the boundaries of the reference system. A further extension of the investigation discloses that scalar motion may also transcend these limits, and take place under circumstances in which it is outside the spatial reference system.

This introduces a question on the borderline between science and philosophy: the issue as to the nature of reality. The orthodox view has been that the "real" world exists *in* the space defined by the conventional reference system, and *in* the time defined by a clock. On this basis it would be possible to classify as real the unobservable phenomena that are located within the reference system, but anything outside that system could not be accorded the "real" status. Heisenberg's atoms, which he located in "abstract multi-dimensional space" therefore had to characterized as phantoms. As he explained,

The idea of an objective real world whose smallest parts exist objectively in the same manner as stones or trees exist, independently of whether or not we observe them . . . is impossible.[46]

Just how a "real" world can be fashioned out of components that are no more than phantoms is a difficult question that most theorists have preferred to ignore. Bridgman, one of the few that have addressed the issue, found it impossible to resolve. His conclusion was that,

The world is not intrinsically reasonable or understandable; it acquires these properties in ever-inereasing degree as we ascend from the realm of the very little to the realm of everyday things.[47]

The clarification of the status of scalar motion now throws a new light on this subject. Scalar motion has the same characteristics wherever we observe it. Since it obviously must be classified as real in its manifestations within the spatial reference system, it must also be real outside that system. This eliminates any justification that may previously have existed for the prevailing view that equates the boundaries of reality with the boundaries of the conventional spatiotemporal reference system.

In order to make the foregoing statements intelligible, it is necessary to explain what is meant by "outside the reference system." There is no space outside the spatial frame of reference, as this is, in principle, unbounded (even if it is finite, as in Einstein's theory). However, the ability of the *spatio-temporal* reference system, which combines the spatial coordinate system with a clock, to represent *motion* (or to represent it correctly) is strictly limited. We have already seen that the representation in the reference system is limited to one of the three dimensions in which scalar motion may take place. In the pages that follow, we will find that there are two additional limitations. First, we will find that there is a minimum distance below which the space-time relations take different forms. This accounts for the difficulties that are being experienced in the realm of the very small, the problems that have led to the belief that the entities of this region do not exist in any real sense. Second, the representation of motion in the conventional spatio-temporal reference system is subject to a speed limit.

Our next objective will be to explore the scalar speed range above this limit, the range in which motion either cannot be represented at all in the conventional reference system, or is not represented in its true character. No phenomena of this nature are recognized by current science.
It follows that if they do exist, as the new information now avai\able indicates, there must be some significant error in current physical thought. The existence of multi-dimensional scalar motion supplies the clue that is needed for identifying this error, the nature of which will be discussed in the next chapter.

CHAPTER 4

Speed Limits

At this point it will again be advisable to emphasize the purely ,factual nature of the development in this work. Perhaps this may seem to be unnecessary repetition, but many of the conclusions reached in the preceding pages are in conflict with currently accepted theories and concepts – products of human thought – and the general tendency will no doubt be to take it for granted that the new conclusions are similar products. On this basis, the issue presented to the reader would be the relative merits of the two lines of thought. But this is not the situation. This volume deals exclusively with factual material. It describes a type of motion that is known to exist, but has not heretofore been examined in detail. With the benefit of this more complete information it then identifies some known phenomena, the true nature of which has heretofore been unknown, as aspects of this scalar type of motion. All this is purely a matter of recognizing existing features of the physical world. No theories or assumptions are involved.

Once the fact that scalar motion exists is recognized, the determination of its properties is a straightforward operation, and the results thereof are equally factual. They do not depend, in any way, on any physical theory, or point of view. As brought out in Chapter 2, one of the significant properties of this type of motion is that, unlike vectorial motion, it is not restricted to one dimension. In a threedimensional universe, scalar motion can take place coincidentally in all three dimensions.

The relevance of the foregoing comments in the present connection is a consequence of the nature of our next objective. We are now ready to take another step in the development of the properties of scalar motion, and the results of this extension of knowledge will again conflict with conclusions that have been reached from current theories. Scientists are understandably reluctant to abandon theories of long standing if this can possibly be avoided. It is important, therefore, to realize that we are not confronting the accepted theories with other theories, we are confronting these current theories with some newly established *facts*.

Of course, it is always painful to find that some idea or theory to which we have long been committed is wrong, and it is particularly distressing when the idea or theory is one that has been successfully defended against strong attacks in the past. The situation that will be discussed in this chapter is one of this nature, but the blow will be cushioned to some extent, as the rejection of the prevailing ideas is not total. We do not find that the theory currently accepted is wrong; we merely find that it claims too much. It has its field of applicability, but that field is considerably narrower than has heretofore been believed.

The question that we will now address is what, if any, limitations exist on speed magnitudes. The prevailing opinion is that the speed of light is an absolute maximum that cannot be exceeded. This opinion is based (1) on experiments, (2) on a theoretical analysis by Einstein, and (3) on the absence of any observation accepted as evidence of greater speeds.

The experiments, originally carried out by Bücherer and Kaufmann, and repeated by many other investigators, involved accelerating electrons and other particles to high speeds by electrical means. It was found that where the applied electric charge is held constant, the acceleration does not remain constant, as Newton's Second Law of Motion, a = F/m, seems to require. Instead it is found to decrease as a funetion of the speed at a rate indicating that it would reach zero at the speed of light. The conclusion that was drawn from this experiment is that it is impossible to accelerate a physical object to a speed greater than that of light.

On first consideration, this conclusion appears to bejustified, and it has not hitherto been successfully challenged, but thejump from the particular case to the general principle has been too precipitous. The electrons and other particles employed in the experiments can probably be taken as representative of matter in general, but there is certainly no adequate justification for assuming that the limitations applying to electrical processes are eclually applicable to physical processes in general. What the experiments demonstrate, therefore, is not that it is impossible to accelerate physical objects to speeds in excess of that of light, but that it is impossible to do so *by electrical means*. Inasmuch as we have found, in the preceding pages, that electrical processes are confined to the one dimension of motion that can be represented in the spatial reference system, the results of this present investigation are consistent with this more limited conclusion. They do not, however, preclude acceleration to higher speeds by some *other* process, such as, for example, the sudden release of large quantities of energy by a violent explosion.

Turning now to the current theoretical view of the situation, Newton's Second Law of Motion,
F = ma, or a = F/ m, which is the form that enters into the present discussion, is a *definition*, and therefore independent of the physical circumstances. It follows that the observed decrease in acceleration at high speeds must be due either to a decrease in the force, F, or to an increase in the mass, m, or both. There is nothing in the experimental situation to indicate which of these alternatives is the one that actually occurs, so when Einstein formulated his theory of high speed motion he had to make what was, in essence, a blind choice. However, charge is known to exist only in units of a uniform size, and therefore has a somewhat limited degree of variability, while mass is much more variable. For this reason a variation in the mass at high speeds appeared to be the more likely alternative, and it is the one that Einstein selected.

The circumstances surrounding scientific developments tend to be forgotten in the course of time, and it is quite generally accepted these days that Einstein must have had some reliable basis for sélecting mass as the variable quantity. An examination of the older textbooks will show that this was not the understanding closer to Einstein's own time. The word "if" figures prominently in the explanations given in these older texts, as in this quotation from one of them: "If this decrease is interpreted as an increase of mass with speed, charge being constant . . ."[48]

The reason for this quite cautious attitude toward the assumption was a general realization at the time that too little was known about the nature of electric charges to justify a firm decision in favor of the variable mass alternative. The findings reported in this work now show that this caution was amply justified. We can now see that it is not the charge that enters into the acceleration equation; it is the force aspect of that charge (motion). A constant charge is a constant motion, not a constant force. The existence of the motion results in the existence of a force, a property of the motion, but there is no legitimate basis for assuming that the force aspect of a constant motion is necessarily constant. On the contrary, it seems rather evident that the ability of a motion to cause another motion is limited by its own magnitude.

The mathematical expression of Einstein's theory, stated in terms of the variable mass concept, has been thoroughly tested, and is undoubtedly correct. Unfortunately, this validation of the *mathematical* aspects of the theory has been generally accepted as a validation of the theory as a whole, including the conceptual interpretation that Einstein gave to it. Acceptance of mathematical validity as complete proof is an unsound practice that is all too prevalent in present–day science. All complete physical theories consist of a *mathematical* statement, and a *conceptual* statement, essentially an interpretation of the mathematics. Validation of the mathematics does not in any way guarantee the validity of the interpretation; it merely identifies this interpretation as one of those that could be correct.

It is much more difficult to validate the interpretation than to validate the mathematics. As soon as it is shown that the mathematics are in full agreement with the observed facts, the mathematical task is complete. Any other mathematical statement that is also in full agreement with the facts is necessarily eduivalent to the first, and in mathematics eyuivalent statements are merely alternate ways of saying the same thing. On the other hand, two different interpretations of the same mathematics are *not* equivalent. The prevailing tendency to accept the first one that comes along, without any rigorous inquiry into its authenticity, has therefore been a serious obstacle to scientific progress. As expressed by Jeans in an oft yuoted statement:

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.[49]

The situation that we are now examining is a good example of the kind of thing that Jeans was talking about. Einstein's theory of high speed motion (that is, his mathematical expression ancl his interpretation thereof) is accepted as having been "confirmed by a large number of experiments," and it is currently part of the dogma of conventional physics. The truth is, however, that those experiments, no matter how great their number may have been, or how conclusive their results, have confirmed only the mathematical aspects of the theory. The point that now needs to be recognized is that the speed limitation does not come from these confirmed mathematics; it comes from the untested interpretation.

If Einstein's *assumption* that the mass varies with the speed is valid, then the mass of a moving object reaches infinity at the speed of light. A greater speed is thus impossible. But this is only one of the possible interpretations of the mathematics, and neither Einstein nor anyone else has produced any tangible evidence to support this interpretation. New "tests of Einstein's theory" are continually being reported, but they are all tests of the *mathematics* of the theory, not tests of the *theory*.

The findings of the scalar motion investigation agree with the mathematical expression of this theory of Einstein's, as they must do, since physical facts do not disagree with other physical facts, but they indicate that he made the wrong guess when he chose mass as the variable quantity in the acceleration equation. It is a decrease in the effective force that accounts for the decrease in acceleration at high speeds, not an increase in the mass. An interesting point in this connection is that there is a universal law that bars the mass alternative, and would have prevented this wrong choice, but unfortunately it has not been accepted to any significant degree by science, even though it plays an important role in many other branches of knowledge. This law, the *law of diminishing returns*, bars infinities – actually it is one expression of the principle that there are no infinities in nature – and it is just as applicable to the acceleration equation as to the many situations in the fields, such as economics, where it is officially recognized. This law tells us that the ratio of the incremental output of a physical process to the incremental input does not remain constant indefinitely, but eventually decreases, and ultimately reaches zero. On the basis of this law, the *effective* force at high speed is not the force measured at low speed, but a quantity that decreases with increasing speed.

In practical applications, such as the design of particle accelerators, for example, Einstein's theory is used in the form of a mathematical equation, and his interpretation of the mathematics does not enter into the result. Consequently, those who use the theory are not particularly concerned as to whether the interpretation is correct or not, and it tends to be accepted without any critical consideration. This casual acceptance of the interpretation by the physicists has placed a roadblock in the way of gaining an understanding of phenomena in which speeds greater than that of light are involved. Since, as we have found, the decrease in acceleration is due to a reduction in the effective force of the electric charge, there is nothing in the mathematical relations that would prevent acceleration to higher speeds where means of applying greater forces are available. This conclusion, reached by correcting the interpretation of Einstein's equation, without affecting the equation itself, is the same conclusion that we reached when we subjected the experimental results to a critical consideration. The mathematics of Einstein's theory describe the process of acceleration by means of a one–dimensional (electric) force. They do not apply to the maximum possible acceleration by other means.

Now let us see how the information about scalar motion presented in the preceding pages fits in with these revised conclusions drawn from the acceleration experiments and Einstein's mathematical development. There is nothing in the scalar motion development thus far that requires a speed limit, but neither is there anything that precludes the existence of such a limit. (The reason for its existence will be derived from some further properties of scalar motion that will be examined in the next chapter.) The previous findings are therefore consistent with the experimental evidence indicating a limit at the speed of light. It is evident, however, from what has been learned about scalar motion that this limit applies to the speed represented in the spatial reference system; that is, it is a one–dimensional spatial limit. Einstein's theoretical conclusion that the speed of light cannot be exceeded will therefore have to be modified *to assert that motion in space in the dimension of the re~érence system cannot take place at a speed greater than that of light.*

Here is a conclusion that agrees with all of the positive evidence. To complete the picture we will also want to take a look at what is offered as negative evidence. The third line of argument currently offered in support of an absolute limit at the speed of light is the asserted absence of any evidence of greater speeds. As applied, however, this argument is meaningless, because anything that might appear to be evidence of speeds beyond that of light is immediately dismissed as unacceptable *because it conflicts with Einstein's theory*. For instance, measurements that appear to indicate that some components of certain quasars are moving apart with speeds up to eight or ten times the speed of light are not accepted as authentic, even though the astronomers are becoming more and more confident of the validity of their measurements.

Aside from these controversial measurements, the significance of which will be considered later, after some further relevant information has been developed, most of the evidence of speeds in the higher ranges is in the form of effects that are not recognizable as products of greaterthan–light speeds without the benefit of an understanding of the properties of scalar motion. Recognition of this evidence by adherents of conventional physical theory therefore could not be expected. But there is one type of actual measurement of speeds greater than the speed of light that should have been recognized in its true light. This is the Doppler shift of the radiation from the quasars.

From the manner in which this shift in the frequency of the incoming radiation is produced, it follows that the relative speed of the emitting object, in terms of the speed of light as unity, is simply the ratio of the shift in wavelength to the laboratory wavelength. There was no suggestion, prior to the discovery of the quasars that there might be any kind of a modification of this relation at high speeds. But when quasar redshifts above 1.00 were measured, indicating speeds in excess of the speed of light, the astronomers were unwilling to accept the fact that they were measuring speeds that Einstein called impossible, so they applied a mathematical factor to keep these speeds below the 1.00 level.

In two other cases, particle acceleration and the composition of velocities, it had been possible to bring the pre–Einstein physical relations into conformity with the values derived by direct measurement at high speeds by applying Einstein's reduction factor

$(1–v2/c2)^{½}$. In the acceleration case, the magnitudes calculated from Newton's Second Law of Motion exceed the speed of light at high speeds, whereas the direct measurement approaches a limit at that speed. The reduction factor is therefore applied to the *calculated* magnitudes to bring them into agreement with the direct measurements. In the composition of velocities, the magnitudes calculated from the relation of coordinate differences to clock time exceed the speed of light, whereas the direct measurements approach a limit at that speed. The reduction factor is therefore applied to the *calculated* magnitudes to bring them into agreement with the direct measurements. The Doppler shifts above 1.00 again confronted the physicists with a situation in which a speed greater than that of light was indicated. The same expedient was therefore employed to keep the indicated quasar speeds within Einstein's limit.

The success of this mathematical expression in the earlier applications, together with the preeminent status accorded to Einstein's limitation on speed evidently conspired to prevent any critical consideration of the justification for applying the same mathematics to the Doppler shift, as it can easily be seen that the Doppler situation is altogether different from the other two. ln both of these other cases, the direct measurement is accepted as correct, and the adjustment factor is applied to the results computed by means of certain relations that hold good at low speeds to bring these calculated results into agreement with the direct measurements. In the Doppler situation there is nothing that needs to be adjusted to agree with the direct measurement. The only magnitude involved is the shift itself, and it *is* the direct measurement.

There is no valid reason for assuming that the Doppler shifts above 1.00 are anything other than direct measurements of speeds greater than the speed of light. It should be noted, however, that on the basis of the points brought out in the preceding discussion, the speed that can be represented in the spatial reference system, the speed that causes change af spatial position, is limited to the speed of light. The inerement above this speed, corresponding to the inerement of the Doppler shift above 1.00, is a *scalar addition* to the speed represented in the reference system. It appears in the Doppler shift because that shift measures the total magnitude of the speed, not the change of spatial position.

The difference between this and the gravitational situation is significant. The gravitational motion that is measured (as a force) takes place *within* the limits of the reference system. In this case, therefore, the *effective* magnitude is fully represented in the reference system. The gravitational motion in the other two scalar dimensions is not so represented, but it has no effect in the dimension of the reference system. On the other hand, a speed in excess of that of light in the dimension that is represented in the reference system is a physical magnitude in that dimension, and even though it cannot be represented by a difference in the spatial coordinates, it participates in any measurement of magnitudes, such as the Doppler shift, which is independent of coordinate differences.

This capability of addition of magnitudes in different speed ranges, independently of the limitations of the spatial reference system, is a general property of scalar magnitudes that has an important bearing on many physical phenomena. As noted earlier, scalar magnitudes cannot be combined in any way analogous to the addition of vectors, but any two scalar quantities in the same dimension are additive. hhus the Doppler shift due to motion in one dimension above unit speed (a scalar quantity) adds to the shift due to motion of the same object in the range below unity (another scalar quantity), which is in the same dimension because the motion in the higher speed range is an extension of the motion in the lower speed range.

Summarizing the foregoing discussion of the question as to the limitations on speed, the evidence shows that it is not possible to accelerate material obiects to speeds in excess of that of light by means of electrical forces. We have found that the electric charge is a onedimensional distributed scalar motion. The meaning of the experimental results therefore is that the speed of light is the limiting speed in one scalar dimension. The three scalar dimensions are independent, and there is nothing to distinguish one from another. It follows that the limiting speed in *each* dimension is the speed of light. Thus the limiting value of the *total* scalar speed of an object is 3c: three times the speed of light. Consequently, there are three speed ranges of scalar motion. One coincides with the range of speed of vectorial motion. Speeds in this range have magnitudes 1–x, where the speed of light is taken as unity, and x is some fraction thereof. If the scalar motion is two–dimensional, the speeds are 2–x, while if the motion is three–dimensional, they are 3–x. The reason for expressing the speeds in this particular manner will be explained in Chapter 6.

The concept of an absolute limit at the speed of light, as laid down by Einstein, is thus erroneous. His mathematics are correct, but they apply only to motion in one dimension, the dimension of the conventional spatial reference system. The new information derived from the investigation of scalar motion makes it evident that the general acceptance of Einstein's conclusion as to the impossibility of speeds greater than that of light has been a monumental roadblock in the way of scientific progress, probably second only to Aristotle's conception of the nature of motion, characterized by Alfred N. Whitehead as "a belief which had blocked the progress of physics for two thousand years." [50]

There is, indeed, a rather close parallelism between the two cases. Both of these serious errors were products of the outstanding scientists of their day: men with many notable achievements to their credit, who had attained such a standing in the scientific community that disagreement with their conclusions was, in effect, prohibited. Both of the conclusions now seen to be erroneous were supported by what originally seemed to be adequate empirical evidence. But both encountered increasing difficulties as physical understanding improved, and both ultimately reached the point where they were maintained as orthodox scientific doctrine on the strength of the authority of their originators, rather than on their own merits. This is generally recognized so far as Aristotle's theory is concerned, where we have the benefit of the historical perspective. It is not so generally appreciated in Einstein's case, but a critical examination of current scientific literature will reveal the remarkable degree to which his pronouncements are treated as incontestable dogma, with a standing superior to the empirical facts.

The gravitational situation has already been discussed. As von Laue admits in the statement that was quoted in Chapter 2, the repudiation of the results of observation "is a result solely of the theory of relativity." The situation with respect to the Doppler shifts of the quasars, mentioned earlier in this chapter, is another instance where the experimental evidence has been reconstructed to agree with Einstein's dictum. The true state of affairs in most other physical areas is obscured by the ad hoc assumptions that are made to "save" the theory, but the prevailing tendency to elevate Einstein's conclusions to an unchallengeable status is clearly illustrated by the general readiness to throw logic and other basic philosophical considerations to the wolves whenever they stand in the way of his pronouncements. Hans Reichenbach, for example, tells us,

This discovery of a physicist (the relativity theory) has radical consequences for the theory of knowledge. It compels us to revise certain traditional conceptions that have played an important part in the history of philosophy.[51]

Kurt Güdel similarly sees far–reaching consequences following from Einstein's interpretation of special relativity, even though it is well known that this is merely the current choice from among a number of equally possible explanations of the mathematical results. M. B. Hesse points this out in the following statement: "There are some other logical questions raised by the theory of relativity . . . because there are a number of alternative theories which all appear observationally equivalent."[52] On this slippery ground, Güdel finds "unequivocal proof."

Following up the consequences (of the assertions of special relativity) one is led to conclusions about the nature of time which are very far reaching indeed. In short, it seems that one obtains an unequivocal proof for the view of those philosophers who… deny the objectivity of change.[53]

Warren Weaver is ready to jettison logic to accommodate Einstein. He tells us that the close observer "finds that logic, so generally supposed to be infallible and unassailable, is, in fact, shaky and incomplete. He finds that the whole concept of objective truth is a will–o'–the–wisp." [54] Now where does this remarkable conclusion come from'? A few pages later in the same work Weaver answers this question. "A major consequence of the developments in relativity and quantum theory over the past half century," he says, has been the destruction of "both ultimate precision and ultimate objectivity," and he goes on to assert that "presuppositions which have neither a factual nor a logical–analytical basis . . . enter into the structure of all theories and into the selection of the group of `facts' to be dealt with." [55]

The revolutionary character of the apotheosis of the relativity theory in modern science cannot be fully appreciated unless it is realized that this logic that Weaver and his colleagues propose to sacrifice on the Einsteinian altar, along with the objective facts of gravitation, Doppler shifts, and other physical phenomena, is one of the basic pillars of the scientific structure. As expressed by F. S. C. Northrop:

In this third stage of inquiry, which permits the introduction of unobservable entities and relations in order to solve one's problem, and which is called the stage of deductively formulated theory, the use of formal logic is a necessity. For it is only by recourse to formal logic that one can deduce consequences from one's hypothesis concerning unobservable entities and relations and thereby put this hypothesis to an empirical and experimental test.[56]

The basic reason for the similarity in the history of the two theories under consideration is that they are both products of *invention*, rather than of *induction* from factual premises. Aristotle was an observer, "a pure empiricist . . . exclusively inductive in his procedure," [57] as described by Northrop. But the amount of empirical knowledge that had been accumulated up to his time was altogether inadequate for his purposes, and he found it necessary to resort to invention to fill in the gap. In his theory of motion, "the things that were in motion had to be accompanied by a mover all the time,"[1] and the "unseen hands" mentioned in Chapter 1, that "had to be in constant operation" to provide this service, were certainly inventions.

Einstein was definitely a protagonist of the "inventive" school of science. "The axiomatic basis of theoretical physics cannot be an inference from experience, but must be free invention," [58] he tells us. Elaborating, in another connection, he further asserts:

The theoretical scientist is compelled in an increasing degree to be guided by purely mathematical, formal considerations in his search for a theory, because the physical experience of the experimenter cannot lift him into the regions of highest abstraction.[59]

Notwithstanding Einstein's brave words, physical science, in practice, resorts to invented principles only when and where inductive results are not available. In Aristotle's day relatively few physical relationships of a general character had been definitely established, and invented principles predominated. By this time, however, the *subsidiary* laws and principles of physical science, including almost all of the relations utilized by the engineers, the practitioners in the application of science, have been derived inductively from empirical premises. Einstein's theories and other products of scientific invention have gained their present ascendancy in the *fundamental* areas only because the previous system of inductive theory applicable to these areas, that generally associated with the name of Newton, was unable to keep pace with the progress of empirical discovery around the end of the nineteenth century.

The reason for this emergence of inventive theory only when there are gaps in the inductive structure is that the inventive theories are *inherently wrong*, in their conceptual aspects. This is an inevitable result of the circumstances under which they are able to gain acceptance. The scientific problems that are responsible for the existence of gaps in the structure of inductive theory do not continue to exist because of a lack of technical competence on the part of the scientists who are trying to solve them, or because the methods available for dealing with them are inadequate. The lack of success, where it exists, is due to the absence of some essential piece, or pieces, of information. If the necessary information is available, there is no need for invention; the correct theory can be derived by induction. Without the essential information it is not possible to construct the correct theory by *any* method.

The gravitational situation is a good example. Newton derived a mathematical expression for the gravitational effect. Subsequently it was found that the range of application of this expression was limited, and Einstein formulated a new expression that presumably has a more general applicability. Both of these were inductive products; that is, they were based on the mathematical aspects of the results of observation and measurement. Neither of the investigators was able to complete his theory by deriving an interpretation of his mathematics inductively. It can now be seen that the reason for this failure was the lack of recognition of the existence of distributed scalar motion. As long as the existence of this *type of motion* was unknown, the identification of the nature of the gravitational effect required for the inductive formulation of the correct gravitational theory was impossible. Newton, who was committed to the inductive approach, was therefore unable to devise *any* complete theory (mathematical statement and interpretation thereof). Without the essential item of information, Einstein was equally unable to formulate the *correct* theory, but on the basis of his contention that the source of basic physical principles must be "free inventions of the human mind," he was at liberty to complete his theory by inventing an explanation to fit the mathematical expression that he had derived.

Whether or not an inventive theory of this kind serves any useful purpose during the time before the correct inductively derived theory becomes available is a debatable issue. So far as the particular phenomena to which the theory is directly applicable are concerned, the conceptual interpretation is essentially irrelevant. For practical purposes, the theory is applied mathematically, and it makes little, if any, difference whether the user understands the real significance of the mathematical operations. As Feynman observes, "Mathematicians . . . do not even need to *know* what they are talking about." [60] The conceptual interpretation of the mathematics is important primarily because it is one of the essentials for an understanding of the relations *between* physical phenomena. While a wrong interpretation may occasionally stimulate a line of thought that leads in the right direction, it is much more likely to impede progress. The justification for the construction and use of inventive theories is therefore highly questionable.

It would appear that the main purpose served by inventing a theory is to enable the scientific community to avoid the painful necessity of admitting that they have no answer to an important problem. What the inventive scientist is able to do, when his inductive counterpart is stymied, is to construct a theory that is *mathematically* correct, and that meets *some* of the conceptual requirements. Until the correct theory appears (or even for a time thereafter, if the Establishment can maintain discipline), the inventive theory can stand its ground on the strength of the assertions (1) that it produces the correct mathematical results (often claimed to be complete verification), and (2) that the assertions of the theory have not been definitely disproved (something that is very difficult to accomplish because of the free use of ad hoc assumptions to avoid contradictions). The extent to which this preposterously inadeduate amount of support is currently accepted as conclusive by a scientific community desperately anxious to have *some kind* of a theory in each fundamental area is graphically illustrated by the description of the prevailing attitude toward Einstein's theories in the preceding paragraphs. However, the fiction can be maintained only for a limited time. Ultimately the inventive theories of Einstein and his school, like the inventive theories of Aristotle, will accumulate too many ad hoc modifications – too many epicycles, we may say – and they will have to give way to theories, derived inductively, that are *both* mathematically and conceptually correct.

Inasmuch as the presentation in this work is purely factual, it does not offer any new inductive theories to replace the inventive theories currently in vogue. It merety calls attention to a large number of hitherto undiscovered, unrecognized, or disregarded physical facts, all of which the theories of physics, inventive or inductive, as the case may be, will hereafter have to be prepared to deal with. From now on, the requirements for acceptance of theories will be substantially enlarged. No theory will be viabte unless it incorporates an acceptable explanation of scalar motion and its conseyuences.

CHAPTER 5

Further Fundamentals

To the earliest thinkers whose ideas are known to us, the directly apprehended world was always inferior to the vast unknown that, they believed, lay beyond it. When so little was known as to the causes of physical phenomena, even the most trivial events could be explained only on the basis of supernatural intervention. In the long march of science from its beginnings more than three thousand years ago to the present era, one after another of these events has been found to be explainable on purely physical grounds. As a result, the pendulum has swung to the other extreme. The currently prevailing opinion not only denies the existence of anything outside the directly apprehended world, but places that world entirely within the limits of the conventional spatio–temporal reference system. According to this present view, the universe exists *in* three–dimensional space, and *in* clock time.

Recognition of the existence of scalar motion makes this view of the universe untenable. Vectorial motion is confined to the conventional reference system because it is, by definition, motion relative to that system. But scalar motion, which has magnitude only, and no inherent relation to the reference system (although, under appropriate conditions, it may *acquire* such a relation by means of an independent process of coupling), is not limited by the reference system. As we saw in the preceding chapter, scalar motion extends into two additional speed ranges beyond the one–dimensional limit at the speed of light to which motion within the reference system is subject. What we will now want to do is to examine the characteristics of motion in these higher speed ranges. As an avenue of approach to this subject we will consider the question of *units*.

It has been found experimentally that electric charge exists only in discrete units. As we saw earlier, charge is simply a name for a onedimensional distributed scalar motion. It has some properties that are not shared by all one–dimensional scalar motions, but these are properties of the distribution, the variable coupling to the reference system, not inherent properties of the scalar motion itself. From the standpoint of the inherent nature of the motion, all one–dimensional scalar motions are alike. It then follows that the limitation to discrete units applies to *any* one–dimensional scalar motion. Furthermore, there is no distinetion between scalar dimensions. Consequently, the limitation applies to scalar motion in general. We thus arrive at this general principle: *Scalar motion exists only in discrete units*.

This conclusion necessarily follows from the observed limitation of electric charge to discrete units. As a necessary consequence of an observed fact, it is itself factual, and does not require confirmation from other sources. Ample confirmation is, however, available. There is substantial evidence for the existence of discrete units of magnetism, two–dimensional distributed scalar motion. The discrete nature of the atoms and particles of matter, the objects that gravitate – that is, experience three–dimensional distributed scalar motion – has been recognized ever since the days of Democritus. The photons of radiation produced by motion of these atoms and particles are likewise discrete units.

The units of charge are *uniform*. The considerations previously discussed in relation to the discrete nature of the units apply with equal force to the uniformity. We may therefore extend the previous statement, and say that scalar motion exists only in *unifórm discrete units*.

From one viewpoint, all physical facts have equal standing, inasmuch as a conflict with any one of them brands a theory or belief as invalid, at least in part. However, some of these facts have much more significant consequences than others, and can legitimately be described as *crucial facts*. The existence of distributed scalar motion is one of these. As has been demonstrated in the preceding pages, recognition of this fact opens the door to a wide variety of significant advances in the understanding of important physical phenomena. Furthermore, it sets the stage for recognition of other facts, some of which have consequences that are sufficiently far – reaching to justify including these facts in the crucial category. The existence of multidimensional scalar motion is one of those that is entitled to be so classified. As will be seen in the pages that follow, the fact that we have just recognized – that scalar motion exists in discrete units only also belongs in this same class. It provides the key item of information that we need in order to make it possible to explore the regions of the universe outside (that is, independent of) the region that is capable of representation in the conventional three–dimensional spatial reference system.

Again, as in Chapter 4, it seems advisable to emphasize the purely factual nature of the presentation, even at the risk of seeming unduly repetitious. A number of the conclusions that will be reached by the factual development in the pages that follow are identical with the conclusions reached in the previous theoretical investigation. The discrete unit limitation, for instance, is one of the basic features of the theory of a universe of motion, as set forth in the previous theoretical publications. Consequently, the conclusions reached in this and the subsequent chapters from the application of this limitation derived from factual premises are also produced in the theoretical development of the motion concept. Because of this agreement on results of a decidedly unconventional nature, there may be a tendency to take it for granted that some theoretical considerations must have entered into the present development of thought. This is not correct. The only way in which the theoretical study has entered into the development in this volume is by providing clues as to where to look for the facts. Of course, this is a significant contribution. In looking for previously unrecognized facts, as in looking for buried treasure, it is extremely helpful to have a map. But the status of what we find, in either case, is not affected in any way by the amount of assistance that we were given toward finding it.

The previous investigation was *purely* theoretical. All conclusions were reached entirely by application of logical and mathematical processes to the postulates of the system, without introducing anything from experience. The objective of this present volume, on the other hand, is to present the maximum amount of information regarding the role of scalar motion in the physical universe that can be derived *without* introducing any theoretical considerations, so that the information about scalar motion will be available to all who are interested in the subject matter, whether or not they are ready to go along with a drastic revision of physical fundamentals.

The limitation of scalar motion to discrete units does not mean that this motion proceeds in succession ofjumps. A uniform motion is a continuous progression at a uniform rate. Because the motion is *continous*, there is a progression within each unit, and one unit follows another without interruption. The discrete unit limitation imposes two restrictions. First, the continuity of the progression can be broken only at ajunetion between units. Fractional units are therefore impossible. Second, any process taking place within a unit cannot carry forward into the next unit.

A chain is an analogous structure. It is composed of discrete units called links, yet it is a continuous entity, not a mere juxtaposition of the links. There are no fractional links. An incomplete link serves no purpose, and is not part of the chain. Properties such as crystal structure do not carry forward from one link to the next. The analogy with scalar motion in this respect could be made even more complete by electrically and thermally insulating the links from each other, as the temperature and electrical conditions existing in each link would then also be independent of those of its neighbors.

The absence of fractional links in the chain does not prevent us from *identifying* different parts of a link, or from utilizing fractions of a link for purposes such as measurement. For example, we can identify the midpoint of a link, and measure a distance of 10½ links, even though there are no half links in the chain. The same principles apply to the discrete units of scalar motion. We can deal with positions and events within a unit on an abstract basis, even though they do not actually exist independently of the unit as a whole.

Scalar motion, as we have seen, has no property other than magnitude. It is a relation between a space magnitude and a time magnitude. Now we further find that these magnitudes occur only in discrete units; that is, we are dealing only with integers. Space and time, so far as they enter into scalar motion, are simply integral numbers of units, reciprocally related, and not otherwise defined. Whether or not they have any other properties in vectorial motion, or in any other connection, is a question that is beyond the scope of this work, which is addressed to scalar motion only. In motion of this type, neither space nor time has any properties other than those appertaining to its status in motion, and time is reciprocally øelated to space. It follows Lhat the properties of scalar motion are simply the properties of reciprocals. These properties are well known in mathematical terms. All that we need to do, therefore, in order to describe the properties of scalar motion under any particular set of circumstances is to translate the mathematical statement of these properties into the language applicable to motion.

Those who are reluctant to accept the finding that time has the status of reciprocal space in scalar motion, because it conflicts with their ideas as to the inherent nature of time, should realize that those long–standing ideas are not scientifically based. This new finding does not conflict with scientific views as to the nature of time, because there are no such views. The nature of time has always been a mystery to science. About all that is known is that time enters into the equations of physics as a variable, and that in some way it moves by us, or we move through it, from the past, to the present, and on into the future. The familiar expression “the river of time” is a reflection of this subjective impression that we get from experience.

Present–day science accepts this vague subjective impression as the definition of time for scientific purposes “without examination,” [61] as Richard Tolman puts it. R. B. Lindsay admits that the “notions of space and time” employed by science are “primitive, undefined concepts,” but contends that “more precisely defined constructs” [62] can be developed, in some unspecified way, farther down the line. Vincent E. Smith is indignant at the suggestion that scientists should be required to define these concepts before using them. “Surely,” he says, “mathematical physicists are exempted from defining such realities as space and time and free to concentrate on only their mathematical aspects.” [63] Other investigators are beginning to realize that this uncritical acceptance of a “primitive, undefined concept” of time as one of the cornerstones of physical science is incompatible with good scientific practice, and are expecting some changes. The following are typical comments:

And perhaps as the domain (of our experience) is broadened still further we may well have to modify our conceptions of time (and space) yet more to enrich them, and perhaps to change them radically.”[64](David Bohm)

Perhaps we are here on the edge of the discovery of a new law of physics that determines how the other fundamental laws depend on time. !t is my feeling that such a law must obviously contain time as one of its basic elements.[65] (G. L. Verschuur)

It is true that space and time appear to be very different. In contrast to the continuing movement that characterizes time, as we observe it, space appears to be an entity that stays put. But the clarification of the relation between space and time in scalar motion throws a new light on the meaning of these observations. The key factor in the situation is the status of unit speed.

The magnitude of a unit of scalar motion is one unit of space per unit of time; that is, unit speed. And since scalar motion exists only in units, its magnitude (speed) on an individual unit basis is *always* unity. However, this magnitude may be either positive or negative, and it is therefore possible to generate net speeds differing from unity by periodic reversals of the scalar direction. As noted in Chapter 1, a continuous and uniform change of direction is just as permanent as a continuous and uniform change of position.

In order to arrive at a negative speed, the reversal of direction must apply to only one component (space or time). Coincident reversals of both components would leave the quotient, the speed, positive. Thus a negative scalar motion is inward either in space or in time, not both. Introduction of reversals of scalar direction in time reduces the net time magnitude without altering the space magnitude, and thus inereases the speed, the ratio of space to time. Similarly, introduction of reversals of scalar direction in *space* reduces the net space magnitude without altering the time magnitude, and thus inereases the ratio of time to space, the *inverse speed*.

From the foregoing it follows that the minimum amount of space that can be traversed in one unit of time is one unit. Anything less than one unit would involve an integral number of units of time per unit of space. This is not speed, but inverse speed, and it cannot be produced by the kind of a process, reversal of scalar direction in time, that produces speed. The minimum speed is therefore unity. Similarly, the minimum inverse speed is likewise unity. In the familiar vectorial type of motion, on the other hand, the minimum speed is zero. Here the condition of rest is zero speed, and effective vectorial speeds are measured from this zero level. Now we see that in a reciprocal speed system the condition of rest, the condition from which effective scalar speed (or inverse speed) magnitudes extend is unity, not zero.

Unit speed is thus the *natural reference level* for scalar motion, the reference level to which the scalar motion of the universe actually conforms. In other words, the reference system for scalar motion is not our stationary spatio–temporal reference system, but a system that is moving at unit speed relative to that stationary system. Both space and time are moving. While “now” moves forward in the manner to which we are accustomed, “here” is moving forward in exactly the same manner. There is no distinetion between reciprocal integers.

What this means in practice is that any object that has no capability of independent motion, and is not acted upon by any outside agency, so that it must remain in its original position, retains its position in the natural reference system, the system recognized by nature, not in the conventional fixed coordinate system, which is a purely arbitrary system selected by human beings for their own convenience. Such an object is carried outward at unit speed relative to the fixed reference system by the motion of the natural system of reference. We are not conscious of the outward progression of space, as we are of the progression of time, because the spatial movement is ordinarily masked by an opposing gravitational motion of the aggregate of matter from which we are doing our observing, but any object that is *not* subject to an appreciable gravitational effect, such as a photon, or a galaxy at an extreme distance, is observed, or deduced by extrapolation, to be moving outward at unit speed (which we can identify as the speed of light), as required by the conclusion that we have just reached from purely factual premises.

We will want to follow the presentation of this evidence that space has the characteristic property of time, the constant progression, with evidence that time has the characteristic property of space, extension into three dimensions. This will require development of another of the consequences of the reciprocal speed relation, and before beginning discussion of this new subject matter it will be desirable to give some further consideration to the question of the nature of reference systems, which has already been introduced.

The reference system in general use, both by scientists and by the public at large, is an arbitrary system. This arbitrary spatio–temporal system recognizes the scalar progression of time, and treats time as continually moving forward at a rate indicated by a clock. The observable spatial motions are mainly motions relative to some particular object, or set of objects, and, for convenience, these objects are treated as stationary for definition of the reference system. The surface of the earth is taken as stationary in most common usage. For other purposes, the center of the earth is assumed to be stationary, while the astronomers find it convenient to use still other arbitrary fixed points.

The justification for the use of an arbitrary reference system of this kind is that the only significant magnitudes under the circumstances of observation are the deviations from the condition taken as a base for the reference system. In dealing with motion on the surface of the earth, for example, we are not concerned with the movement of the earth around the sun, or the movement of the solar system around the center of the galaxy, in which all objects on the earth's surface are participating. These motions are irrelevant because they do not change the relative positions of the objects in which we are interested. When we undertake to analyze fundamental motions, the situation is quite different. In order to evaluate these motions, we must have a reference system relative to which an isolated object with no inherent motion does not move.

The orthodox doctrine at present is that there is no such reference system, because, it is contended, motion is relative, rather than being a specific deviation from some motionless absolute base. "There is no meaning in absolute motion," [66] is the assertion of those who follow Einstein in this respect. But this view encounters serious difficulties. The fixed stars do provide a background to which observations can be referred. Indeed, those who attempt to explain away the various "paradoxes" to which relativity theory is subject often call upon "acceleration relative to the fixed stars"[67] as a way out of their difficulties. Richard Feynman likewise resorts to astronomy to provide a fixed reference system, as in the following statement:

We cannot say that all motion is relative. That is not the content of relativity. Relativity says that uniform velocity in a straight line relative to the nebulae is undetectable.[68]

Werner Heisenberg offers this comment:
This is sometimes stated by saying that the idea of absolute space has been abandoned. But such a statement has to be accepted with great caution . . The equations of motion for material bodies or fields still take a different form in a "normal" system of reference from another one which rotates or is in a non–uniform motion with respect to the "normal" one. [69]

The key to an understanding of this rather confused situation is a recognition of the place of scalar motion in the picture. As long as "motion" is taken to be synonymous with "vectorial motion," all motion is, by definition, relative to something arbitrary, and no absolute reference system can be defined. But the assumption that all motion is vectorial motion is not valid. Scalar motion does exist, and it does have an absolute datum level, or effective zero, at unit positive (outward) speed. When a negative scalar motion at unit speed is superimposed on the basic unit positive speed, the net result is a speed that is *mathematically* equal to zero (as distinguished from unit speed, which is the physical datum, or condition of rest, the physical zero, we might say). A set of objects with speeds of zero (mathematically) constitutes a reference system that is absolute in nature, and is appropriate for use by the inhabitants of the sector of the universe in which we live, although as indicated earlier, such a reference system is capable of representing only a very limited portion of the total physical universe. The distant astronomical objects, whose vectorial motions are negligible because of the great distances intervening, constitute such a stationary system.

For analytical purposes, we need to recognize that the zero datum of this fixed system is a composite, and that the datum level of the *natural* reference system is defined by the one–to–one space–time ratio (speed) of the fundamental units. As seen in the context of the fixed spatial coordinate system, the natural reference system appears as a uniform outward progression of space coinciding with a uniform increase in the registration on a clock. Thus, when no physical interaction is taking place, all objects that appear stationary in a fixed reference system are, in fact, moving inward at unit speed. Objects such as photons, that have no capacity of independent motion and must remain in the same absolute location (the same location in the natural reference system) in which they originate, are carried outward relative to the fixed reference system, at this same unit speed, by the progression of space.

This is the background pattern of the scalar motions of the universe. The development that follows, in which independent physical activity will be introduced, will proliferate rapidly into a wide variety of significant conclusions, and unless the successive steps in the development of thought are specifically noted, it may be hard to believe that so many consequences would necessarily follow from such a limited set of factual premises. It therefore needs to be emphasized at the outset that all of these conclusions are so derived, without bringing in any assumptions or theories, and that they all have the factual status.

The fundamental physical action of the universe is a result of the existence of independent units of scalar motion, the net effect of which is to oppose the outward progression of the natural reference system. If that outward motion continues unimpeded, there can be no interaction between units. Nor can any interaction result from independent motion in the outward direction superimposed on the outward progression, as this, if possible, would merely accelerate the dispersal of the units. But independent motion in the inward scalar direction is capable of bringing the units close enough together to permit interaction. The requirement that the net motion of the independent units must be directed inward means that the *basic* independent scalar motion must have the inward scalardirection. This basic motion can be identified as gravitation.

A gravitating object, moving outward by reason of the progression of the natural reference system, and inward by reason of gravitation, may acquire additional independent motions of a different character. As indicated earlier, the net resultant of a combination of motions may be either a *speed,* which, on a onedimensional basis, is one unit of space per n units of time, or an *inverse speed*, n units of space per unit of time. (lntermediate values are produced by combination with units having the full one–to–one space–time ratio.) A speed, 1/n, decreases the amount of space per unit time below the normal unit ratio, thus causing a change of position in space, while the time progression continues at the normal rate. Such motion is *motion in space*.

An important feature of a reciprocal system is that it is symmetrical around the unit level. The temporal relations in scalar motion are therefore subject to the same general considerations as the spatial relations, but recognition of this fact has been blocked by erroneous ideas as to the relation of space and time. Up to about the beginning of the present century it was generally believed that space and time are independent. The increase in knowledge since then has revealed that this is incorrect, and that there is actually some kind of a connection between the two. The current opinion is that one dimension of time joins with three dimensions of space in some manner to form a four–dimensional space–time continuum. The role of time in this hypothetical four–dimensional structure is vague. In order to constitute an added dimension of the spatial structure, time must be some kind of a quasi–space, but just how its spatial aspect is supposed to differ from ordinary space is not specified in current theory. Actually, it is difficult to see how one dimension of an n–dimensional structure could differ from another in *any* way other than in magnitude, if the results of calculations involving different dimensions are to have any meaning.

In any event, the discrete unit limitation leads to a quite different view of the space–time relation, as we have seen. Like the theory that calls for the propagation of the gravitational effect through a mediumlike space, and the other theories that are in conflict with the *facts* disclosed by the scalar motion investigation, the four–dimensional space–time concept will therefore have to be discarded. It should be noted, however, that neither this nor the modifications of current thought required by the findings reported in the earlier chapters amount to a wholesale rejection of present–day physical theory. The fabric of that theory is such that there is only a minimum amount of connection between its various parts. As described by Feynman, "the laws of physics are a multitude of different parts and pieces that do not fit together very well."[32] This absence of positive connections is, of course, a weakness in the body of theory, but it is nevertheless advantageous in the present instance, as it enables excluding those aspects of existing thought that are in conflict with the factual results of the scalar motion investigation without affecting much of the remainder of accepted theory.

Because of the symmetry around the unit speed level, the conclusions that were reached with respect to scalar motion with speed 1/n also apply, in inverse form, to motion with inverse speed 1/n, equivalent to speed n/1. This inverse speed increases the amount of space per unit time; that is, it alters positions in time while the space progression takes place at the normal rate. Motion at inverse speeds is thus *motion in time*.

It is true that no evidence of such a property of time is now known to science. However, all that this means is that the existing evidence is not currently recognized as such. As we saw in
Chapter 2, it has been found that there is a serious discrepancy between the "time" that is registered on a clock and the "time" that enters into the equations of motion. Now we further find that the clock registers only the time of the progression of the natural reference system, while the total time involved in motion from one location to another includes the separation in time between the locations. This separation is negligible at low speeds, but is significant at high speeds. Here is the alternative that Einstein overlooked when he concluded that "there is no other way" of meeting the situation disclosed by the measurements at high speeds but to abandon the concept of absolute magnitudes.

Inasmuch as the universe is three–dimensional (a fact of observation), position in space is position in three–dimensional space. The position in time that is altered by motion in time is the same kind of a position, differing only in its reciprocal nature. Motion in time has no direction in space, but it has a property that corresponds to spatial direction, and can logically be called direction in time. Position in time is therefore position in *three–dimensional time*.

Here, then, we have demonstrated the other half of the proposition, stated earlier in this chapter, that each of the components of motion has the principal property of the other.

The findings previously discussed showed that the principal characteristic of time, its continual progression, is likewise a property of space. Now, by deduction from factual premises, it has been shown that the principal characteristic of space, its three–dimensional extension, is also a property of time.

Because of the particular location from which we view physical events, the two situations *appear* quite different. We observe the time progression directly, and detect the independent motion in time only by its effect on the magnitudes of certain physical quantities. In the spatial situation the reverse is true. We observe the independent motion in space directly, and detect the space progression only by its effect on some physical quantities. The reason for this difference is that we who are observing these phenomena exist in a sector of the universe in which changes of position take place in space. In this *material sector*, as we will call it, all material objects are, as we know from observation, moving inward gravitationally in space. This inward gravitational motion counterbalances the outward progression of the natural reference system, and leaves us approximately at rest relative to a fixed spatial coordinate system. From this vantage point we are able to detect the independent motion in space, but we cannot observe the space progression directly.

An important consequence of the existence of motion in threedimensional time on a basis coordinate with that of motion in threedimensional space is that there is an inverse sector of the universe, the *cosmic sector*, we will call it, similar to our own material sector, but differing in that space and time are interchanged. If there are observers in this sector, they can observe the space progression and the independent motion in time directly, but they can detect the time progression and the independent motion in space only by their effect on the magnitudes of certain physical quantities.

This is a region of the universe of the kind mentioned earlier, one that is not capable of representation in the conventional spatial reference system. One dimension of the motion in this cosmic sector could, however, be represented in a temporal reference system analogous to the spatial system. Such a reference system would consist of a three–dimensional pattern of time coordinates, in which changes of position in time take place during the continuous outward progression of space, measured by a device analogous to a clock.

In this present discussion we are dealing with scalar motion only, but it can be deduced that at least some of the vectorial motions that take place within our familiar spatial reference system are duplicated in the cosmic sector. Without extending the investigation to the details of vectorial motion, which, as matters now stand, is not feasible without a theoretical analysis, we cannot say that *all* of the vectorial phenomena of the material sector are so duplicated, but in view of the reciprocal relation between space and time in scalar motion, we can say that this is true of all scalar motion phenomena, including gravitation. The existence of gravitation requires the existence of matter in corresponding amounts. Thus matter, too, is duplicated in the cosmic sector. Inasmuch as the probability of a deviation in the temporal direction, speed n/1 , from the scalar speed datum, 1/1 , is equal to the probability of a deviation in the spatial direction, speed 1/n, the quantities of all of these entities that do exist in the cosmic sector are commensurate with the quantities of the corresponding entities in the material sector. The cosmic sector is thus coextensive with the material sector, whether or not it is an exact duplicate (another point that requires a theoretical analysis). Here, then is a second full–scale division of the universe.

This is a far–reaching conclusion of great importance, one that, at a single stroke, doubles the size of the universe. The general reaction to a new idea of this magnitude is one of considerable skepticism, but the existence of an "antiuniverse" is clearly suggested by a number of recent additions to physical knowledge, and has been the subject of numerous speculations. As expressed by Asimov:

Somewhere, entirely beyond our reach or observation, there may be an antiuniverse made up almost entirely of antimatter.[70]

The results of the investigation reported herein have now identified the reality behind these speculations. The existence of this "anti" (actually inverse) sector of the universe is a necessary consequence of the facts about scalar motion that have been ascertained in the course of an intensive investigation, and presented in the preceding pages. Furthermore, the key conclusions in this factual line of development are corroborated by observational evidence. Direct observation of the inverse phenomena is not possible because the cosmic sector is almost entirely outside our observational range. The reason for this is that the entities and phenomena of that sector are distributed throughout three–dimensional time. The various physical processes to which matter is subject alter positions in space independently of positions in time, and vice versa. As a result, the atoms of a material aggregate, which are contiguous in space, are widely dispersed in time, while the atoms of a cosmic aggregate, which are contiguous in time, are widely dispersed in space.

It should be noted that the dispersion takes place in the space and time of the respective three–dimensional reference systems, and does not alter the position in the space–time progression (the outward motion of the natural reference system). The limitation of the concentration of matter to either space or time, not both, effectively separates the material (space) sector of the universe from the cosmic (time) sector. We of the material sector are moving through threedimensional time in one scalar dimension – a one–dimensional line of progression – and as a consequence, only a relatively small proportion of the cosmic phenomena eome within the range that is accessible to us. Furthermore, since the components of cosmic aggregates are contiguous in time, not in space, the cosmic phenomena that we do encounter are not in the forms in which they can be recognized as counterparts of the known phenomena of the material sector. Physical phenomena are primarily interactions of aggregates, or of concentrated radiation from aggregates, and the aggregates of one sector are not recognizable as such in the other.

We can, however, deduce the forms in which certain phenomena of the cosmic sector will appear in our reference system, and we can then compare these deductions with the results of observation. We can deduce, for instance, that electromagnetic radiation is being emitted from an assortment of sources in the cosmic sector, just as it is here in the material sector. Radiation moves at unit speed relative to both types of fixed reference systems, and can therefore be detected in both sectors regardless of where it originates. Thus we receive radiation from cosmic stars and other cosmic objecis just as we do from the corresponding material aggregates. But these cosmic objects are not aggregates in space. They are randomly distributed in the spatial reference system. Their radiation is therefore received in space at a low intensity and in an isotropic distribution. Such a background radiation is actually being observed. It is currently attributed to remnants of the Big Bang, but there is no real evidence as to how it originates. The significant fact in the present connection is that the conseyuences of the existence of scalar motion in discrete units *require* a radiation of this nature.

The same considerations also account for the apparent absence of "antimatter" in the expected quantities. All current physical theories (including the theory of a universe of motion) incorporate symmetries from which it can be concluded that matter in the ordinary form and iri some "anti" form should exist in approximately equal quantities. There is no observational evidence of the existence of *any* antimatter aggregate, and the question, Where is the antimatter?, has become a serious issue for the physicists and the astronomers. This present development supplies the answer. The matter of the cosmic sector is inversely related to the matter of the material sector; it is the missing antimatter. Since the cosmic sector is the inverse of the material sector, and coextensive with it, cosmic matter is just as plentiful in the universe as a whole as ordinary matter, but because it is aggregated in time rather than in space, we do not meet it in the form of stars, or galaxies, or even small lumps. We meet it only one atom at a time, and because of the very small portion of the three–dimensional expanse of time that ever comes within our observational range, we encounter only a limited number of these atoms. These are the cosmic rays. The answer to the antimatter question then is: It exists, but most of it is outside our range of observation.

Antimatter itself is accepted as a reality. All current physical theories define the structure of matter in such a way that the units atoms and particles – of which the material aggregates in our environment are composed are paralleled by a series of similar units of an "anti" nature. Some of the less common observed units have been identified as members of this antimatter class, and the existence of aggregates of antimatter is asserted by most theories, although there is no observational evidence of such aggregates. Since matter is one of the principal features of the known physical universe, the general agreement as to the existence of antimatter goes a long way toward acceptance of an antiuniverse, such as the inverse sector that we find exists.

The reciprocal relation between space and time in scalar motion, from which the conclusions outlined in the foregoing paragraphs are derived, is simply the relation between the numerator and denominator of a fraction, and it is incontestable, but it is worthwhile mentioning that the reciprocity clearly does hold good in the only relation between space and time that is actually known observationally: the relation in motion itself. In motion, more space is the eduivalent of less time. It makes no difference whether we travel twice as far in the same time, or take half as much time to travel the same distance. The effect on the speed, the measure of the motion, is the same in both cases. The significance of this point has been obscured to some extent by the fact that direction, in our ordinary experience, is a property of space only, and this seems to distinguish the space aspect of motion from the time aspect. Recognition of the existence of scalar motion changes this situation, as it shows that vectorial direction is not an essential property of motion. When it is realized that there are some motions without an inherent direction, and some that have direction in space, the conclusion that there are still others that have direction in time follows duite naturally.

Although the concept of three–dimensional time, and the many important consedueneces that result from its existence, may seem to involve a major departure from previous scientific thought, a review of the progress in fhis field in the past hundred years shows that the thinking of the scientific profession has been gradually moving in this direction. As in some of the problems discussed earlier, the first step was taken by Einstein. Before his day, it was generally agreed that the time applicable in one location is applicable everywhere, and under all conditions. Einstein found that this led to inconsistencies under some conditions, particularly at high speeds. He therefore rejected the idea of universal simultaneity, and introduced the assumption that two events simultaneous in one system of coordinates are not simultaneous in a relatively moving system. On the basis of this hypothesis, the rate of progression of time, instead of being constant, varies with the speed of movement.

Many of those who have accepted Einstein's view of the relativity of simultaneity, and have tried to explain it in textbooks orotherwise, have (perhaps unknowingly) improved upon the original ideas, and have come very close to seeing the situation in the light in which it now appears as a result of the findings of the scalar motion investigation. For instance, Marshall Walker puts the case in this manner:

It had been assumed that an absolute time existed such that any timers anywhere could be synchronized with it. Nature was pointing out most emphatically that such absolute time does not exist. We will see later that it is as nonsensical to expect in general to find the same "time" at two different places as it is to expect to find the same "point" at two different places.[71]

Here Walker draws an analogy between the "point" (that is, location in space) at a "place," and the "time" (that is, location in time) at a "place." The analogy thus recognizes that there are locations in time, just as there are locations in space. It follows that there is a difference in time between any two such time locations. All this is in accord with the findings described in the preceding pages. But Walker stopped here and did not take the next logical step, recognition of the fact that the differences in time between the various locations are independent of the time registered on a clock.

Identification of the properties of scalar motion now reveals that the true explanation of the difference in time between stationary and moving systems is not that simultaneity is relative, but that two different time components are involved.Clock time is a measure of the *time progression*, and since this is simply the outward movement of the natural frame of reference, all locations in the universe are at the same stage of the progression. Thus the pre–Einstein view of time is correct to this extent. The time component of the progression of the natural reference system conforms to Newton's view of the nature of time in general. The problems that have arisen in applying clock time to high speed processes are not due to any variability in clock time itself, but to the fact that the total time entering into these processes includes an additional component of an indepenent nature: the difference in time between the locations that are involved. The reyuirement in

Einstein's theory that the clock must indicate the *total* time amounts to a demand that this device, which performs one operation (measuring the relative motion of the two reference systems) when stationary, must take on an additional task of a different kind (measuring the difference in time between locations) when it is moving.

The possibility of motion in time has been a subject of speculation for centuries, and is a favorite in the science fiction field. It is generally rejected by scientists, not because there is any actual evidence that rules it out, but because this idea conflicts with the subjective impression of time as a continual flow. The option of rejection is no longer open. The existence of motion in time is now seen to be a necessary consequence of observed physical facts, and it is therefore itself factual. The status of scalar motion as a reciprocal relation between integers requires the existence of a system of scalar motions in time symmetrical with the scalar motions in space. Motion in time is now one of the known features of the universe with which all theories and all individual viewpoints must come to terms.

It should be noted, however, that the kind of motion in time, or "time travel," that the science fiction writers envision, and that most individuals think of when the subject is mentioned, is movement along the line of the scalar progression; that is, travel to an earlier or later era. In the light of the findings of this work, time travel of that nature is impossible. The time progression is a result of the motion of the natural reference system relative to the fixed reference system, and it is therefore not subject to any kind of modification. The motion in time that is being discussed here involves a change of position in threedimensional time independent of, and coincident with, the change of time position due to the progression of the natural reference system. It is analogous to the change of position within one of the distant galaxies due to motion in space, while the time registered on a clock is analogous to the space traversed in the recession of the galaxy.

The possibility of returning to the time and place of a past event, one of the favorite goals of the "time travel" enthusiasts, is definitely excluded. We are already aware that this objective cannot be accomplished by travel in space. It is possible, in principle, to return to any specified point in space, but we cannot return to the same place at the same time. We can only reach it at some later time. Travel in time is subject to exactly the same kind of a limitation (another result of the reciprocal relation). It is possible, in principle, for an object capable of existing at the speeds of the cosmic sector to return to any specified point in time by means of time travel, but this point cannot be reached at the same place. It can only be reached at some more distant location.

CHAPTER 6

The General Picture

Translation of the mathematical properties of reciprocals into the physical terms applicable to scalar motion, a reciprocal relation between space and time magnitudes, in the preceding chapter revealed that there necessarily exists an inverse sector of the universe in which the scalar motions of our familiar material sector are duplicated in inverse form with space and time interchanged. The phenomena of one dimension of the inverse type of motion can therefore be represented in a three–dimensional temporal reference system corresponding to the three–dimensional spatial reference system in which spatial motion is customarily represented. Our next undertaking will be to extend our consideration of the properties of reciprocals to an investigation of the intermediate regions between the regions represented in the two types of three–dimensional reference systems.

For this purpose we will need to consider the manner in which the primary scalar motions are combined. As noted earlier, the photons of radiation have no capability of independent motion, and are carried outward at unit speed by the progression of the natural reference system, as shown in (1), Diagram A. All physical objects are moving outward in the same manner, but those objects that are subject to gravitation are coincidentally moving inward in opposition to the outward progression. The information developed from the investigation of scalar motion does not indicate the exact nature of the gravitating objects, which we identify from observation as atoms and sub–atomic particles, but for present purposes this knowledge is not essential. When the gravitational speed of such an object is unity, and equal to the speed of progression of the natural reference system, the net speed relative to the fixed spatial reference system is zero, as indicated in (2). In (3) we see the situation at the maximum gravitational speed of two units. Here the net speed has reached –1, which, by reason of the discrete unit limitation, is the maximum in the negative direction.

DIAGRAM A

		Motion	**In Out**	**Net**
(1)	Photon	Progression	|——>	+1
(2)	At grav.	Progression	|——>	0
	limit	Gravitation	<——|	
(3)	At maximum	Progression	|——>	–1
	gravitation	Gravitation	<——|——	
(4)	At zero	Progression	|——>	0
	net speed	Gravitation	<——|——	
		Translation	|——>	
(5)	At unit	Progression	|——>	+1
	net speed	Gravitation	<——|——	
		Translation	——|——>	

An object moving with speed combination (2) or (3) can acquire a translational motion ín the outward scalar direction. Thís ís the type of motion with which we will be concerned in the remainder of this volume. One unit of the outward translational motion added to combination (3) brings the net speed relative to the fixed reference system, combination (4), to zero. Addition of one more translational unit, as in combination (5), reaches the maximum speed, +l, in the positive scalar direction. The maximum range of the equivalent translational speed in any one scalar dimension is thus two units.

As indicated in Diagram A, the independent translational motions with which we are now concerned are additions to the two basic scalar motions, the inward motion of gravitation and the outward progressíon of the natural reference system. The net speed after a given translational addition therefore depends on the relative strength of the two original components, as well as on the size of the addition. That relative strength is a funetion of the distance. The dependence of the gravitational effect on distance is well known. What has not heretofore been recognized is that there is an opposing motion (the outward progression of the natural reference system) that predomínates at great dístances, resultíng ín a net *outward* motion.

The outward motion (recession) of the distant galaxies is currently attributed to a different cause, the hypothetical Big Bang, but this kind of an ad hoc assumption is no longer necessary. Clarification of the properties of scalar motion has made it evident that this outward motion is something in which *all* physical objects participate. The outward travel of the photons of radiation, for instance, is due to exactly the same cause. This is a significant point because no tenable explanation of this phenomenon has heretofore been available, and the conclusion derived deductively from the new facts discovered in the scalar motion investigation fills a vacuum in the existing structure of physical theory. Einstein is generally credited with having supplied an explanation, but actually he conceded that he was baffled. In one of his books he points out that this is an extremely difficult problem, and he concludes that

Our only way out . . . seems to be to take for granted the fact that space has the physical property of transmitting electromagnetic waves, and not to bother too much about the meaning of this statement.[72]

Objects, such as the galaxies, that are subject to gravitation, attain a full unit of net speed only where gravitation has been attenuated to negligible levels by extreme distances. The net speed at the shorter distances is the resultant of the speeds of the two opposing motions. As the distance decreases from the extreme values, the net outward motion likewise decreases, and at some point, the *gravitational limit*, we will call it, the two motions reach equality, and the net speed is zero. lnside this limit there is a net inward motion, with a speed that increases as the effective distance decreases. Independent translational motions, if present, modify the resultant of the two basic motions.

Aggregates of matter smaller than the galaxies are under the gravitational control of larger units, and do not exhibit the same direct connection between distance and net speed that characterizes the galaxies. The same two opposing basic motions are, however, effective regardless of the size of the aggregate, and the equilibrium to which they lead can be recognized in a number of astronomical phenomena. The globular star clusters are a good example. These clusters are huge aggregates of stars, up to a million or more, in a nearly spherical structure, that are observed in the outlying regions of the larger galaxies. No viable explanation has heretofore been found for the continued existence of such a cluster. Only one force is known to be applicable, that of gravitation, and an equilibrium cannot be established without the presence of some equally powerful antagonist. Rotational forces often play the antagonist role in astronomy, but there is little rotation in these clusters. A dynamic equilibrium, as in a gas, has also been suggested, but a gas sphere is not a stable structure unless it is confined. On the basis of what is now known, the cluster should either dissipate relatively quickly, or collapse into one central mass. It does neither. Since there is no explanation available, the whole issue has been shelved by the astronomers for the time being.

The outward progression of the natural reference system now supplies the missing ingredient. Each star is outside the gravitational limits of its neighbors, and therefore has a net outward motion away from them. Coincidentally, however, all stars are subject to the gravitational effect of the cluster as a whole. In a relatively small cluster the inward gravitational motion toward the center is not sufficient to hold the cluster together, but as the size of the cluster increases, the gravitational effect on the outer stars increases correspondingly. In a very large aggregate, such as a globular cluster, the net motion of the outer stars is inward, acting against the outward motion of the inner stars, and confining all stars to equilibrium positions.

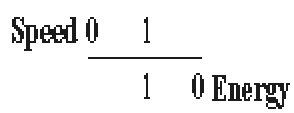
Once the nature of the cluster equilibrium is understood, it is evident that the same considerations apply to the galaxies, although the rotational forces in these more complex structures modify the results. The existence of the scalar motion equilibrium accounts for some otherwise unexplained properties of the galactic structure. For instance, the minimum observed separation between stars in the outer regions of the Galaxy (aside from that in double or multiple star systems) is more than two light years, an immense distance that is inexplicable without some specific obstacle to a closer approach. The existence of an equilibrium distance similar to that in the globular clusters now provides the explanation. The fact that the stars occupy equilibrium positions rather than moving freely in interstellar space also gives the galactic structure the characteristics of a viscous liquid, which explains a number of effects that have heretofore been difficult to understand, such as the confinement of quantities of high energy matter in the central regions of certain galaxies.

The units of translational motion that are applied to produce the speeds in the higher ranges are outward scalar units superimposed on the motion equilibria that exist at speeds below unity, as shown in combination (5), Diagram A. The two–unit maximum range in one dimension involves one unit of speed, s/t, extending from zero speed to unit speed, and one unit of inverse speed, t/s, extending from unit speed to zero inverse speed. At this point it will be convenient to identify inverse speed as *energy*. This identification plays no part in the development of thought in the remainder of this work, and anyone who is inclined to question it can simply read “inverse speed “ wherever “energy” appears in the subsequent discussion. The reason for using the “energy” designation is to keep the terminology of this work uniform with that of the previous theoretical publications. As has been emphasized repeatedly in the foregoing pages, this work is purely factual, and independent of any theory, but the conclusions reached herein are identical, as far as they go, with the corresponding results of the theoretical investigation. Inasmuch as these factual conclusions conflict with currently accepted physical theory in many respects, they constitute strong evidence in favor of the validity of the theory of a universe of motion. Many readers of this volume will no doubt wish to examine the published descriptions of that theory, and to facilitate such an examination it is desirable to use the same terminology that was employed in the theoretical publications.

For the benefit of those who may feel that the use of the term “energy” in this significance is definitely ruled out by a conflict with the kinetic energy equation, in which the energy varies as the syuare of the velocity, rather than being inversely related, it should be noted that the energy does not vary with v^2 alone, but with mv^2. As we found earlier, mass is a measure of a distributed scalar motion. Thus mv^2 is a compound motion, a motion of a motion. Energy, in this context, is *velocity of a mass*. Since we are not undertaking to develop a theory of motion in this work, we are not in a position to establish the ecluivalence of this compound motion and the inverse of simple scalar motion, but the status of mv^2 as a compound motion means that there is nothing in present–day physical theory (which does not recognize this kind of motion) to indicate that the presence of the v^2 term in the energy equation is inconsistent with the identification of inverse speed as energy. This is all that it is necessary to know for present purposes.

Unit speed and unit energy are equivalent, as the space–time ratio is 1/1 in both cases, and the *natural* direction is the same; that is, both are directed toward unity, the datum level of scalar motion. But they are oppositely directed when either zero speed or zero energy is taken as the reference level. Zero speed and zero energy in one dimension are separated by the equivalent of two full units of speed (or energy) as indicated in this diagram:

DIAGRAM B



In the foregoing paragraphs we have been dealing with full units. In actual practice, however, most speeds are somewhere between the unit values. Since fractional units do not exist, these speeds are possible only because of the reciprocal relation between speed and energy, which makes an energy of n/1 equivalent to a speed of 1/n. While a simple speed of less than one unit is impossible, a speed in the range below unity can be produced by addition of units of energy to a unit of speed. For reasons that require a theoretical explanation, and are therefore beyond the scope of this factual presentation, the quantity 1/n is modified by the conditions under which it exists in the spatial reference system, and appears in a different mathematical form, usually $1/n^2$ (actually $[l / n]^2$).

In this connection, it may be well to point out that this work does not undertake to supply the reasons why things are as they are – that is the task of fundamental theory. Where the reasons are necessary consequences of known facts, they are, of course, included with the other factual material, but otherwise the results of observation are accepted as they are found. In the case now being considered, the second power expression, $1/n^2$, is well established empirically, appearing in numerous observationally verified relations.

As noted earlier, unit speed and unit energy are oppositely directed when either zero speed or zero energy is taken as the reference level. The scalar direction of the equivalent speed $1/n^2$ produced by the addition of energy is therefore opposite to that of the actual speed, and the net speed in the region below the unit level, after such an addition, is 1–

$1/n^2$. Motion at this speed often appears in combination with a motion $1–1/m^2$ that has the opposite vectorial direction. The net result is then
$1/n^2–1/m^2$, an expression that will be recognized as the Rydberg relation that defines the spectral frequencies of atomic hydrogen – the possible speeds of the hydrogen atom.

The net effective speed $1–1/n^2$ inereases as the applied energy n is inereased, but inasmuch as the limiting value of this quantity is unity, it is not possible to exceed unit speed (the speed of light) by this inverse process of adding energy. To this extent, we can agree with Einstein's conclusion. However, his assertion that higher speeds are impossible is incorrect, as there is nothing to prevent the direct addition of one or two *full units* of speed in the other scalar dimensions. As we saw in Chapter 4, this means that there are three speed ranges, identified in that chapter as 1–x, 2–x, and 3–x.

Because of the existence of three speed ranges with different space and time relationships, it will be convenient to have a specific terminology to distinguish between these ranges. In the subsequent discussion we will use the terms *low speed* and *high speed* in their usual significance, applying them only to the region of three–dimensional space, the region in which the speeds are 1–x. The region in which the speeds are 2–x – that is, above unity, but below two units – will be called the intermediate region, and the corresponding speeds will be designated as *intermediare speeds*. Speeds in the 3–x range will be called *ultra high speeds*.

Inasmuch as the three scalar dimensions are independent, the two–unit range between zero speed and zero energy applies to each of these three dimensions individually. Thus the total separation between zero speed and zero energy on the full three–dimensional basis is six units of speed (or energy). The midpoint that divides the material (space) sector from the cosmic (time) sector is three units. In practice, however, neither net speed nor net energy exceeds the two–unit level by any significant margin, because of the gravitational effects. This is illustrated in Diagram C, which shows the relations between the speeds and energies of the two sectors.

DIAGRAM C
SCALAR UNITS OF SPEED AND ENERGY

1.	Material sector	at s=0		0	1	2	3		
2.		at s>1		1	2	3			
3.	Natural system		0	1	2	3	(2)	(1)	(0)
4.		at t>1				(3)	(2)	(1)	
5.	Cosmic sector	at t=0			(3)	(2)	(1)		

The middle line in this diagram (number 3) shows the total speeds and energies (in parentheses), with 3 units of either speed or energy as the midpoint. Where gravitation is absent, as it is (on the individual mass unit basis) at any distance above that corresponding to unit speed, or any inverse distance above that corresponding to unit energy (lines 2 and 4), the effective speeds are the same as in line 3. The upper (1) and lower (5) lines show the net values with gravitation included.

The significance of this diagram is that it demonstrates that the effective maximum net speed (or energy) is not three units, the midpoint between zero speed and zero energy, but two units. We know from observation that at the normal (low) speeds of the material sector the spatial density of matter is great enough to subject all aggregates to gravitational effects. In view of the reciprocal relation, we can deduce that the same is true of the density in time in the cosmic sector. Motion in space does not change the density in time, and vice versa. It follows that when the net spatial speed (translational less gravitational) reaches 2 units (line 2), gravitation in time becomes effective, and the motion is at the (3) level on the energy basis (line 5).

Summarizing the foregoing discussion, we may say that the physical universe is much more extensive than has hitherto been realized. The region that can be accurately represented in a spatial frame of reference is far from being the whole of the universe, as conventional science assumes that it is. There is another equally extensive, and equally stable, region that is not capable of representation in any spatial reference system, but can be correctly represented in a three–dimensional temporal reference system, and there is a large, relatively unstable, transition zone between the two regions of stability. The phenomena of this transition zone cannot be represented accurately in *either* the spatial or temporal reference systems.

Furthermore, there is still another region at each end of the speed–energy range that is defined, not by a unit speed boundary, but by a unit space or time boundary. In large–scale phenomena, motion in time is encountered only at high speeds. But since this inversion from motion in space to motion in time is purely a result of the reciprocal relation between space and time, a similar inversion also occurs wherever the magnitude of the *space* that is involved in a motion falls *below* the unit level. Here motion in space is not possible because less than unit space does not exist, but the *equivalent* of a motion in space can be produced by means of a motion in time, since an energy of n/1 is eyuivalent to a speed of 1/n. This region within one unit of space, the *time region*, we may call it, because all change that takes place within it is in time, is paralleled by a similar *space region* at the other end of the speed–energy range. Here the equivalent of a motion in time is produced inside a unit of time by means of a motion in space.

As we have just seen, in connection with the combination of speeds and energies to produce net speeds below unity, the mathematical expression of the speed equivalent of an energy magnitude may take a form that differs from the expression of the corresponding speed. This difference in the mathematics, together with the substitution of energy for speed, accounts for the difficulty, mentioned in Chapter 3, that conventional physical theory is having in defining the phenomena of the realm of the very small in "real" terms.

With the addition of these two small–scale regions to those described above, the speed regions of the universe can be represented as in Diagram D.

DIAGRAM D

Speed		**0**		**1**		**2**				
	time	**:**	**3d**	**:**	**scalar**	**:**	**3d**	**:**	**space**	
	only	**:**	**space**	**:**	**zone**	**:**	**time**	**:**	**only**	
				2		**1**		**0**		**Energy**

The extent to which our view of the physical universe has been expanded by the identification of the properties of scalar motion can be seen from the fact that the one section of this diagram marked “3d (thr~e–dimensional) space” is the only part of the whole that has been recognized by conventional science. Of course, this is the only region that is readily accessible to human observation, and the great majority of the physical phenomena that come to the attention of human observers are phenomena of this three–dimensional spatial region. But the difficulties that physical science is currently encountering are not primarily concerned with these familiar phenomena; they arise mainly from attempts that are being made to deal with the universe as a whole on the basis of the assumption that nothing exists outside the region of three–dimensional space.

Our results show that the principal problems now confronting physics and astronomy stem from the fact that observation and experiment have penetrated into these regions that are beyond the scope of the three–dimensional space to which present–day theorists are limiting their vision. The phenomena and entities of the hitherto unrecognized regions of the physical universe interact with those of the region of three–dimensional space only at widely scattered locations. We therefore encounter them one by one at apparently unrelated points. For a full appreciation of their significance it needs to be realized that all of these seemingly isolated items are constituent elements of a vast physical system that is mainly beyond the reach of our physical facilities.

The concept of phenomena that 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 time 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 spatial reference systems is a drastic change, to be sure, but the fact that such an extension turns out to be required should not surprise anyone who is familiar with the history of science.

As indicated in Diagram C, when the distance exceeds 1.00, the gravitational limit, and gravitation is consequently eliminated, the limiting value of 2–x is at the sector boundary. Any further addition to the speed results in entry into the cosmic sector. It is possible, however, for an object to acquire a translational speed of 3–x and still remain in the material sector until the opposing gravitational motion is reduced to the point where the net total speed of the object reaches two units.

Thus far we have been considering the successive units of speed purely as magnitudes. On this basis, they are all equivalent. As we saw in Diagram B, however, the second unit in each scalar dimension is a unit of energy, rather than a unit of speed. lt is equivalent to a unit of speed in magnitude, but in relation to zero speed it is inverse, and opposite in direction. Motion in this speed range is in time. The effect of the reversal at the unit level is to divide the two sectors of the universe into regions in which the relation between the natural and arbitrary spatial reference systems changes at each regional boundary. Since the natural system is the one to which the universe actually conforms, any process that, in fact, continues without change across a regional (unit) boundary reverses in the context of the arbitrary fixed spatial reference system. Each region thus has its own special characteristics, when viewed in the context of the spatial reference system.

The observed characteristics of motion in the intermediate region, for instance, are quite different from those of motion in the speed range below unity. However, the differences are introduced by the connection to the reference system; they are not inherent in the motions. So far as the scalar motion itself is concerned, these are two one–unit positive magnitudes of the same nature. The fact that one of these motions takes place in space, and the other in time, is a result of their relation to unity, the natural datum, or zero level.

A speed 1–x is less than unity, and it causes a change of position in space, without effect on position in time (relative to the natural datum). A speed of 2–x, in the intermediate range, is greater than unity, and it causes a change of position in time. Further addition of speed, bringing the motion into the 3–x range, the uJtra high speed range, puts it over the one–dimensional limit of two units, and into the spatial unit of a second dimension. Such a motion is outward in space in the second dimension, while it continues outward in time in e first dimension. As noted earlier, coincident motion in both space and time is impossible. But we have seen that a motion with energy n/1 in time is equivalent to a motion with speed 1/n in space. As long as the gravitational effect is strong enough to keep the net total speed below the sector limit of two units, the motion as a whole continues on the spatial basis. The motion in time that takes place in the 2–x and 3–x speed ranges while the net speed is below two units is therefore a motion in *equivalent space*.

The upper speed ranges are duplicated on the energy side of the neutral level. Corresponding to the intermediate speed range is an intermediate energy range, with energy 2–x, where x is the fractional energy eyuivalent of n units of speed. In this energy range, the motion as a whole continues on the time basis as long as the net total energy remains below the two–unit level. The motion in space that takes place in this 2–x energy range is therefore a motion in equivalent time.

Similarly, a motion component in the 3–x energy range, which involves motion in time in one dimension and motion in space in a second dimension, continues as a motion in ecluivalent time as long as the net total energy remains below the level at which gravitation begins acting in space.

Like the phenomena of the low energy range, the region of threedimensional time, the events taking place in the two upper *energy* ranges are outside our observational limits, and we know them only by analogy with the corresponding events on the space side of the neutral level. However, events in the upper *speed* ranges produce some effects that are observable. An examination of these effects will be our next undertaking, and will be the subject of Chapter 7.

Some general comments about the contents of this present chapter are in order. First, it may seem that the large number and broad scope of the conclusions that have been reached are out of proportion to the base from which it is asserted that they are derived, inasmuch as the stated objective was to derive them from the mathematical properties of reciprocals. It should be remembered, however, that the point brought out in Chapter 5 was that application of these mathematical properties to *any particular set of physical circumstances* would define the physical properties. Notwithstanding the essential simplicity of scalar motion, it is subject to a wide variety of such physical circumstances, by reason of (1) the existence of positive and negative scalar magnitudes, (2) the limitation to discrete units, and (3) the three–dimensionality of the physical universe. The number of permutations and combinations of these factors is enormous.

The second point that warrants some consideration is the logical status of the conclusions that have been reached with respect to the phenomena of the regions intermediate between the region represented in the conventional spatial reference system and the corresponding inverse region. It has been found empirically that certain things (using the term in a broad sense to include both entities and phenomena) *do* exist in the physical universe. These, particularly the ones that have not heretofore been recognized, constitute the basis for the development of thought in this present volume. In the course of this development, we find that certain things *must* exist as a consequence of the things that we observe *do* exist. For example, we have seen that the observed existence of a fundamental force requires the existence of a fundamental motion. Further results of the development of the consequences of the established facts in both of these categories then reveal that certain other things *can* exist. Ordinarily, this would not imply that they do exist, but there is one intluential school of thought in science that takes the stand that *in nature* anything that can exist (or happen. There is no clear distinction, from the natural standpoint, between what exists and what happens) does exist. K. W. Ford expresses this point of view:

One of the elementary rules of nature is that, in the absence of a law prohibiting an event or phenomenon, it is bound to occur with some degree of probability. To put it simply and crudely: anything that *can* happen *does* happen.[73]

In any event, whether we can assert that some physical objects actually do attain speeds in the intermediate and ultra high ranges, or whether the most that we can legitimately say is that they can attain such speeds, what we need to do in order to bring speeds of this magnitude into the factual picture that we are developing in this work is to identiJv' physical objects whose properties coincide with the properties of objects moving at speeds in excess of that of light. lt is evident that such objects, if they exist, are astronomical. This introduces some difficulties into the identification process. The amount of observational information about astronomical phenomena is, in many cases, severely limited. "What is a quasar? No one knows,"[74] says Gerrit Verschuur (1977). Why is the matter of the universe aggregated into galaxies? "This is the most glaring and basic unsolved problem in astronomy,"[75] according to M. J. Rees. To make matters worse, an unknown, but probably substantial, proportion of what is currently regarded as knowledge is actually misinformation. "Much of what is known today must be regarded as tentative and all parts of the field have to be viewed with healthy skepticism."[76](Martin Harwit)

In order to compensate for the scarcity of reliable information about the nature and properties of the individual astronomical entities, the identifications based on comparison with this information will be supplemented by identification of entire *classes* of objects or phenomena. For example, a whole class of compact astronomical objects will be identified as material aggregates whose high density is due to the same cause: component speeds in the intermediate (2–x) range. Similarly, a process of aggregation, observed only at isolated points, will be identified in its entirety. It could be said that the next chapter, in which most of these identifications will be made, is, in total, a comparison of the properties of the intermediate region, as derived by deduction from factual premises, with the corresponding region of the astronomical universe. In other words, it is an identification of the intermediate region as a whole. Chapters 5 and 6 were devoted entirely to the development of the relevant facts. Now Chapter 7 will be devoted entirely to the process of identification.

In the course of this identification process, however, we will advance our understanding of the intermediate speed region a step farther than was possible in the preceding discussion. The physical entities that we will identify as moving at speeds greater than unity are active participants in large–scale physical activity. Thus, in examining and identifying these entities we will also be deriving a general picture of the large–scale *action* of the universe.

CHAPTER 7

Astronomical Identifications

As explained in the preceding chapter, in order to bring out the full significance of the hitherto unrecognized physical facts that were discovered in the course of the systematic investigation of the nature and properties of scalar motion, it is necessary to identify the phenomena to which these facts are relevant, and to interpret them in the light of the new information. The areas of physical science outside the region represented in the conventional three–dimensional spatial system of reference are mainly in the realm of astronomy, and the new information now available therefore requires some changes in the views that now prevail in the astronomical field. Inasmuch as *many* heretofore unrecognized facts of a significant nature, and important consequences thereof, were derived from factual premises in Chapters 5 and ó, and are now to be related with astronomical knowledge, it follows that some *major* changes in astronomical thought will be required.

Since they are necessary consequences of the newly established facts, these revisions of existing ideas will have to be made regardless of the attitude of the astronomical community, but it is interesting to note that the astronomers have already recognized the implications of the existing problems, and have, to a considerable extent, reconciled themselves to the inevitability of major changes. Harwit summarizes the existing situation in this manner:

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.[76]

The general tendency in astronomical circles is to lay the blame on the physicists, and to join with Hoyle in calling for a "radical revision of the laws of physics."[77] Here are some of the statements that echo this theme:

In some places, too, the extraordinary thought begins to emerge that the concepts of physical science as we appreciate them today in all their complexity may be quite inadequate to provide a scientific description of the ultimate fate of the universe?[78] (Bernard Lovell)

Is it possible that the solution to the quasar mystery will involve a fundamental rethinking of the basic physics to which we have been growing accustomed since Albert Einstein's time?[74] (Gerrit Verschuur)

At the present time, the so–called "energy problem" (accounting for the energy of the quasars) is widely considered to be the most important unsolved problem in theoretical astrophysics, and it is believed by some that the final solution will only come after astronomers have rewritten some of the laws of fundamental physics.[79] (Simon Mitton)

Whether or not the new facts reported in this work, and their consequences, constitute a "radical revision of the laws of physics" is a matter of opinion, but it is true that they require a radical revision of current ideas in certain areas of astronomy. This may not bejust what the astronomers have been asking for, but it cannot be expected that a major change in fundamentals can be accomplished without some significant effect on the superstructure that has been erected on those foundations. It should be no surprise, therefore, when application of the information developed in the preceding chapters leads to some substantial modification of the prevailing views in astronomy as well as in physics.

Most astronomical phenomena are located entirely within the region of three–dimensional space, and are therefore capable of representation in the conventional reference system. It is generally recognized that gravitation is the controlling factor in this region. As we have seen, gravitation is a rotational phenomenon, a rotationally distributed scalar motion. Since it is directed inward, it causes an increasing concentration of this type of motion; that is, the aggregates of matter in the region of three–dimensional space continually increase in size. The astronomers have been slow to realize that this is an inexorable process, dominating the physical situation all the way from sub–atomic particle to giant galaxy, but the following statement by Martin Ryle is an indication that a general understanding is emerging:

What we now need is an understanding of the physical mechanisms involved in the formation of a galaxy from the primeval gas, and its subsequent evolution from this earliest stage to that involving the sudden enormous energy production apparent in radio galaxies and quasars.[80]

It is evident from observation that, unless the universe is in a relatively early stage of development, there must be some kind of a limitation on the process of aggregation under the influence of gravitation. Otherwise, as Einstein noted, "The stellar universe ought to be a finite island in the infinite ocean of space." [81] Lovell elaborates the same thought in these words:

The application of Newton's theory of gravitation, in which the attraction between bodies varies inversely as the square of their distance apart, to the large–scale structure of the universe would require that the universe had a centre in which the spatial density of stars and galaxies was a maximum. As we proceed outwards from this centre the spatial density should diminish, until finally at great distances it should be succeeded by an infinite region of emptiness.[82]

Einstein's answer to this problem, as in his treatment of the problem resulting from the discovery of the constant speed of light, was to devise a *marhematical* reconciliation of the conflict by means of an ad hoc modification of the geometry of space. The need for any such dubious expedient in the situation we are now considering is eliminatcd when it is recognized, as in the quotation from Ryle, that the evolutionary course in the realm of astronomy reaches its climax in events that involve extremely energetic processes, and that there are quite definite limits on the sizes of the aggregates. The individual objects, the largest of which are stars (or stellar systems), reach an upper limit somewhere in the neighborhood of 100 solar masses. "Superstars" with much larger masses appear in many theoretical speculations, but get no support from observation. The aggregates of stars, the largest of which are galaxies, are similarly restricted to the range below about 10^{12} or 10^{13} solar masses. As expressed by Hoyle, "Galaxies apparently exist up to a certain limit and not beyond that."[83]

The correlation of the energetic events with maximum size is clear. One class of the violent stellar explosions known as supernovae has been identified with the hot massive stars at the upper end of the main sequence. There is also evidence of violent activity in the largest class of galaxies – strong radiation extending over a wide range of frequencies, ejection of matter in clouds and jets, and in some cases definite indications of catastrophic explosions.

As matters now stand, we cannot determine from observation whether space is Euclidean or non–Euclidean, but the need for a departure from Euclidean geometry to resolve the problem cited by Einstein and Lovell in the quotations above is eliminated when the existence of limits on size is recognized. The galaxies *are* "finite islands in the ocean of space," but only up to the limiting magnitude. The existence of this limit shows that the loss of mass in the explosive events that characterize the giant galaxies prevents building up any larger aggregates.

The exact nature of the ejecta from these explosions, and from the supernovae, has not yet been definitely established from observation, but obviously some of the matter thrown off in these violent events leaves at very high speeds. The true magnitude of these speeds is not currently known. It is *assumed* in present–day thinking that they cannot exceed the speed of light. However, as we have seen in the preceding pages, the possible speeds extend into a much higher range. lt will be appropriate, therefore, to examine the effects of speeds in the ranges above unity (the speed of light), as they appear on application of the principles established in the earlier chapters, and to compare these effects with the results of observation of the explosion products.

All explosive events generate some low speed (less than unit speed) products. If the explosive forces are isotropic, these products are ejected in all directions as an expanding cloud of matter. If those forces are anisotropic, some, or all, of the products take the form of an identifiable aggregate moving outward from the scene of the explosion. In either case, these are purely phenomena of the threedimensional region, and they have no bearing on the activity in the upper speed ranges that we are now examining. The explosion products with which we are now concerned are the fast–moving products of explosions that are powerful enough to give some of the ejected fragments speeds greater than that of light.

As brought out in Chapter 6, motion in the intermediate speed range takes place in time (equivalent space) rather than in space, but is otherwise similar. Matter ejected at speeds in excess of unity by an explosion therefore takes the form of a cloud of particles similar to the cloud of particles that is expanding into space at the lower speeds. Here we need to keep in mind that the various scalar motions of an object are independent. It therefore does not necessarily follow that because one of them takes the inverse form – motion in time rather than motion in space – that all of them assume the inverse status. Thus there exist not only the phenomena of spatial motion, and the inverse thereof, but also phenomena of an intermediate character, in which one or more motions of an object attain speeds that put them into the ranges that constitute motion in time, while others remain on the spatial basis. For instance, the motions of the *components* of the object may be in the intermediate range, while the object itself moves at low speed.

The fastest product of one of the two types of supernova explosion is in this intermediate category. It is an expanding cloud of particles centered on the explosion site (if the explosive forces are isotropic, as observation indicates that they usually are), and identical with the expanding cloud of low speed particles, except that, since the particles are moving with intermediate speeds, they are expanding into time rather than into space.

Because of the directional inversion at the unit level, this expansion *reduces* the equivalent space, the size of the cloud as seen in the spatial reference system. Thus, if a portion of the explosion products of a supernova attain intermediate speeds, as we may expect in view of the violence of the explosion, the second product is a relatively small aggregate, a small star, of extremely high density, and relatively high surface temperature. The spatial speed imparted to this explosion product as a whole is zero, and the position in space is not altered. The effects of the intermediate explosion speed are internal. Externally, the behavior of the product star is the same as that of a normal star. These characteristics of the intermediate speed product are identical with those of the observed *white dwarf* star.

The idea of a decrease in the observed size of a physical object by reason of expansion of its constituents into three–dimensional time will no doubt occasion some conceptual difficulty for many readers, not because there is anything illogical or irrational about the idea, but simply because it conflicts with long–standing beliefs about the nature of physical realities. This is the same kind of a situation that science has encountered over and over again since its beginnings some thousands of years ago. Such ideas as a flat earth, a “perfect” unchanging realm in the skies, a geocentric universe, heat as a “substance,” nature’s “abhorrence” of a vacuum, spontaneous generation of life, and so on, were just as firmly implanted in the minds of our ancestors as the prevailing concept of the nature of time is in the human minds of today. Andjust as those cherished, and strongly defended, ideas had to be discarded, or appropriately modified, when definite evidence to the contrary was forthcoming, so the currently prevailing assumptions about time will have to be altered to the extent required by the facts uncovered in the scalar motion investigation. The newly discovered basic facts are clear and undeniable once they are brought to light, and science has no option but to accommodate itself to them.

As will be demonstrated in the pages that follow, the scalar motion findings that provide this new explanation of the properties of the white dwarf stars also explain a wide variety of other recently discovered astronomical phenomena, including some that have no explanation at all in terms of current astrophysical theory. Before undertaking an examination of these other phenomena, however, it may be helpful to those who are still troubled about the idea of an upside–down density relationship if we take a look at a situation in which the inverse density gradient is clearly demonstrated.

In our ordinary experience, the components of a heterogeneous fluid separate according to density, if not continually stirred. The heavier molecules migrate to the bottom of the container, and the lighter ones accumulate at the top. The same kind of a separation also takes place in ordinary stars. Some mixing may occur by reason of rotation of the star, but the amount of rotation is not usually sufficient to eliminate the separation; it merely reduces the extent to which the separation is carried. The center of the star is the “bottom” from a gravitational standpoint, and in an ordinary star the heaviest elements accumulate preferentially in the central regions, while the outer layers are enriched in hydrogen, the lightest element. Since hydrogen is the predominant constituent of the star, it is difficult to confirm the expected small amount of enrichment, but nothing that is now known is inconsistent with the conclusion that the normal kind of separation by density occurs.

On the basis of the explanation of the structure of the white dwarf stars that has just been given, the density gradient in these stars should be inverse. The region in the center of the star is the region of greatest compression in time, which is ecluivalent to expansion in space. The center of the star is thus the region of least density, while the surface layers have the highest density. The surface layers of the white dwarf should therefore be preferentially enriched in helium, the heavier of the two principal constituents of the star, and the center of the star should be almost entirely hydrogen.

A review article by James Liebert in the 1980 *Annual Review of Astronomy and Astrophysics* supplies the information needed in order to compare these conclusions with the results of observation. This comparison is unequivocally in favor of the existence of the inverse density gradient. 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. The existence of an inverse density gradient in the white dwarfs solves the puzzle. The helium accumulates in the outer layers because these are the regions of greatest density in the white dwarfs.

These findings with respect to the helium concentration are further confirmed by Liebert's report on the behavior of elements heavier than helium, commonly lumped together as "metals" in discussions of stellar composition. There is some inflow of matter into these stars from the environment, the metal content of which is known. Like the helium, these incoming metals should preferentially accumulate in the regions of greatest density, the outer layers of the white dwarfs. Liebert describes the observed situation in this manner:

The metals in the acereted material should diffuse downward, while hydrogen should remain in the convective layer. Thus the predicted metals–to–hydrogen ratio should be *at or below solar* (interstellar) values, yet real DF–DG–DK stars have calcium–tohydrogen 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 physical theory. Liebert admits that no plausible explanation on the basis of current astronomical thought is known. The only suggestion that he mentions is that the accretion of hydrogen might be blocked by some kind of a mechanism, a far–fetched idea without the least support from observation. Here, then, is a positive demonstration of the inverse density gradient that is required when the white dwarf stars are identified as objects whose components are moving with speeds in the intermediate range. The light molecules sink to the bottom (the center of the star) while the heavy molecules remain on top, just as they must if the constituents of the star are expanding into time.

The white dwarfs were the first of a class of *compac astronomical objects* to be discovered. Almost fifty years elapsed before the next discovery. In the meantime a theory, based on a set of ad hoc assumptions, was formulated to explain the unusual features of the white dwarfs, and by the time the next objects of this class appeared on the scene the increased acceptance that comes with familiarity had given the white dwarf theory a safe place in astronomical thought. Since this theory was specifically tailored to the white dwarfs, it was not applicable to the new compact objects, the quasars, and efforts (so far not very successful) had to be made to develop a new theory for the quasars. A few years later the pulsars joined the group, and again a new theory was required. Fortunately for the theorists, relatively little is known about the basic features of the pulsars, and a theory based on the assumed existence of a hypothetical class of objects called neutron stars was found to be capable of being stretched far enough to cover most of the available items of knowledge. It could also be adapted to most members of a class of compact x–ray emitters subsequently located, but other members of this class were too large to fit within the limits calculated for the white dwarfs and neutron stars. The black hole hypothesis was invoked to meet this situation.

So in order to explain the different astronomical manifestations of *one* physical phenomenon – extremely high density – we have an ever–growing multitude of separate theories, one for the white dwarfs, 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. By this time it should be evident, even without the new information derived from the investigation reported in this present work, that a complete overhaul of the theory of the compact objects is essential in order to eliminate the extraordinary diversity of ideas applied to this one phenomenon. Their comrnon feature is the extremely high density, and the contribution of this volume is to identify the cause of that density as speeds in the intermediate range, between one and two times the speed of light. This explanation is applicable to *all* of the observed types of compact object, regardless of size, and regardless of whether the components of the object are particles or stars.

On the basis of this explanation, all of the compact objects are explosion products. This is currently conceded in astronomical thought, except in the case of the dense galactic cores, which are still in the "mystery" category. This limitation implies that the cause of the high density is some aspect of the explosion process. It is conceivable that a violent explosion might actually be a combination explosion and implosion that would leave a compact remnant at the explosion site, as currently believed, but the details of this hypothetical process are vague. Furthermore, no one has bothered to explain how an implosion can produce the kind of high translational speeds that are observed features of all quasars, most pulsars, and many x-ray emitters. The known feature of violent explosions that *can* explain the behavior of all of these compact objects is an ejection speed in the ranges above untiy; that is, the explanation is forthcoming if the properties of scalar motion, as described in the preceding pages, are taken into consideration.

We have been able to identify the explosion that produces a white dwarf as a supernova, because it must be a single star in order to have a product that is single and of stellar size. There is observational evidence indicating that explosions involving galaxies, or large segments thereof, also occur. The exact nature of the galactic explosions and their products is still open to many questions, as the data from observaticn are incomplete and difficult to interpret, but we can deduce that the intensity of such an explosion is substantially greater than that of a supernova, a very much smaller aggregate of matter. It can therefore be concluded that the maximum speeds of the galactic ejecta are substantially higher than those of the supernova products that constitute the white dwarfs, and are probably in the ultra high range. We can also deduce that since the galaxies are aggregates of stars rather than aggregates of particles, the ejected matter will consist, in part, of stars. Thus, just as the intermediate speed product of the explosion of a star is a smaller star, the ultra high speed product of the explosion of a galaxy should be a smaller galaxy, a galactic fragment.

Furthermore, as we found in Chapter 6, the ultra high speed has a spatial component. Instead of remaining at the explosion site in the manner of the white dwarf, the product of the galactic explosion, the galactic fragment, moves outward from the scene of the explosion at a high rate of speed. Although the explosion speed itself is in the ultra high range from the start, the *net* speed of the ejected fragment remains at a lower level for a considerable period of time because the inward gravitational motion in the explosion dimensions has to be overcome before the explosion speed can be fully effective. In the interim the fastmoving galactic fragment is observable.

Let us see then just how this fragment should appear to observation. First, we can deduce that the explosion that imparted ultra high speed to the fragment as a whole applied some of its energy to accelerating the constituent stars. The stellar speeds will no doubt be less than that of the aggregate, but we can conclude that at least a large proportion of them will be in the next lower speed range, intermediate speed. On this basis, the stars of the ultra high speed fragment, like the particles of which the white dwarf star is composed, are expanding into time. This explosion product is thus a white dwarf galaxy; not a galaxy of white dwarf stars, but a galaxy that, aside from its high outward speed, has the characteristic white dwarf properties, a high energy density and an abnormally small size.

These white dwarf characteristics result from the intermediate speeds of the stars *in* the ejected fragment. Some further distinctive properties are contributed by the ultra high speed of the fragment as a whole. As explained in Chapter 6, ultra high speed involves motion in time (equivalent space) in one dimension and motion in space in another. One of these scalar dimensions is coincident with the dimension of the conventional spatial reference system, and the redshift of the galactic fragment reflects the total speed in this dimension. Since this includes half of the explosion speed, as well as the normal recession speed due to the outward motion of the natural reference system, the redshift of the galactic fragment is much greater than that of an ordinary galaxy at the same spatial distance.

These are the properties of galactic fragments ejected at ultra high speeds by violent explosions, as defined by the factual information developed in the preceding pages. What we now want to know is whether there are any observed objects that have these same properties, and can therefore be identified as the fast–moving explosion products. The answer is clear. The objects known as quasars answer the description; they are apparently small galaxies or galactic fragments; they are abnormally small for objects of this class; their energy output is abnormally high relative to their sizes; and their redshifts are far above those of any other known objects.

The origin of the quasar redshifts is one of the most controversial subjects in present–day astronomy. The great majority of the astronomers accept the “cosmological” explanation, which ascribes the entire redshift to the normal galactic recession, and thus places the quasars at extreme distances. A relatively small, but persistent, group of dissenters challenges this conclusion, and contends that these objects are actually much closer, a hypothesis that requires some of the redshift to be produced by something other than the normal recession. The debate has continued ever since the very large redshifts were discovered, but the question is no closer to resolution. The problem is that there is a head–on collision between redshift theory and energy generation theory. If the redshifts are cosmological, then the indicated energy emission is so enormous that no known process can come anywhere near accounting for it. On the other hand, if the quasars are closer, so that the energy emission can be explained, then a new explanation has to be found for the excess redshift. Obviously something has to give. One or the other of the two limiting assumptions has to be abandoned.

For some reason, the logic of which is difficult to understand, the majority of astronomers seem to believe that the redshift alternative is the only one that requires a revision or extension of existing physical theory. The argument most frequently advanced against the contentions of those who favor a non–cosmological explanation of the redshifts is that a hypothesis that requires a change in physical theory should be accepted only as a last resort. Dennis Sciama puts the case in this manner:

My own view is that in discussing these localised phenomena, one should work extremely hard to fit them into the accepted laws of physics. Only after persistent failure should one introduce new laws.[84]

What Sciama and his colleagues are overlooking is that in this case the last resort is the only thing left. If modification or extension of existing theory to explain the redshifts is ruled out, then existing theory must be modified or extended to explain the energy generation. Furthermore, the energy alternative is much more drastic, as it not only requires the existence of some totally new process, but also involves an enormous increase in the *scale* of the energy generation, a rate far beyond anything heretofore known. All that is required in the redshift situation, on the other hand, is a heretofore unrecognized process. This process is not called upon to explain anything more than is currently regarded as within the capability of the recession process; it merely has to account for the production of the observed redshifts at less distant spatial locations. Even without the new information derived from the scalar motion investigation, it should be evident that the redshift alternative is by far the better prospect for solving the impasse between the redshift and energy generation theories. It is therefore significant that this is the explanation that emerges from the scalar motion study.

Of course, we have to accept the world as we find it, but it is worth noting that here, as in many instances in the preceding pages, the answer that emerges from a development of the consequences of the newly established physical facts takes the simplest and most logical path. Indeed, this answer to the redshift problem does not even involve breaking as much new ground as has been expected by those astronomers who currently favor a non–cosmological explanation. As they see the situation, some new physical process or principle must be invoked in order to add a "non–velocity component" to the recession redshift of the quasars. But we find that no such new process or principle is required. The additional redshift is simply the result of an added speed – one that has hitherto escaped recognition because it is not capable of representation in the conventional spatial reference system.

The reduction in the quasar distances that results when the explosion component of the redshift is taken into consideration also provides the answer to the problem raised when it was discovered that there are individual parts of certain quasars that are moving apart with speeds which, on the basis of the cosmological distance theory, are many times the speed of light. As reported by Verschuur, "This discovery caused quite a furor."[85] Some tentative explanations have been advanced, but "none of these answers is fully satisfactory."[86]

Inasmuch as one of these tentative answers was that "the distances to quasars might be incorrectly indicated by their redshifts," the answer that we now find is the correct one, it is interesting to note the reason that Verschuur advances for rejecting it. If we accept this explanation, he tells us, "we would have to question all redshift measurements and hence the expanding universe model."[86] This is typical of much of the reaction to proposals for modification of existing theories. All too often such proposals are summarily rejected, as in this case, on the strength of arguments based on the general situtation defined by existing theory, without any consideration of the possibility that this situation, within which the modification would take place, is itself changed by the new proposal. In the present instance, it is simply assumed that whatever new factors enter into the determination of the redshifts of the quasars, in the context of the new proposal, are applicable to all other redshifts. There is no reason why this should necessarily be true. Indeed, the development in this work shows that it is *not* true. The explanation that we have derived from factual premises does not affect any redshifts other than those of objects moving with ultra high speeds. The only such redshifts that have been measured are those of the quasars.

When the redshift situation is straightened out, as indicated above, there is full agreement between the conclusions derived from the scalar motion investigation and the principal observed quasar properties. A substantial amount of empirical information about various details of the structure and behavior of these objects has also been accumulated, but a theoretical analysis is required in order to account for these details. The initial results of such an analysis were reported in the author's 1971 publication Quasars and Pulsars. They will be extended and updated in the astronomical volume of the series, begun with *Nothing But Motion*, that will present a full description of the theory of a universe of motion.

The objects known as pulsars (with a few possible exceptions) have the outward spatial motions that are characteristic of the duasars, but sizes comparable to those of the white dwarfs. In the light of what has been said in the preceding paragraphs, it is evident that this combination of stellar size and outward motion could be produced by a stellar explosion violent enough to impart ultra high speed to some of the products. The probability that this is the correct explanation of the pulsar origin is indicated by the existence of two distinct kinds of supernovae, Type I and Type II, one of which is considerably more powerful than the other.

The results of the investigation reported in this volume do not identify the cause of the supernova explosion, other than indicating that it takes place at some limiting stage of the evolution of the star; that is, at an age or size limit. The correlation of the explosive activity of the galaxies with a maximum size indicates that the galaxies are also subject to some kind of an evolutionary limit, but there is evidence to suggest that the primary events in the galactic case are stellar explosions rather than actual galactic processes. One such indication comes from the previously mentioned evidence of the existence of dense cores in certain galaxies. On the basis of the information developed in the preceding pages, the abnormal density of these cores is due to the same cause as the extremely high density of the white dwarfs, the quasars, and other compact astronomical objects; that is, speeds in the intermediate range, between one and two times the speed of light. Our galaxy has a relatively small core of this nature. M 87, the closest giant, has a much larger and much denser core. Radiation at radio frequencies, which is apparently related to the activity in the core, shows a similar correlation with the size of the galaxy.

This pattern suggests that the accumulation of matter with speeds in the higher ranges begins in the early spiral stage, and continues at an accelerating rate, reaching a climax in the giant galaxies when the confined material blows out a section of the overlying structure of the galaxy in the manner of a boiler explosion. On this basis, it might be expected that there would be some instances in which the fast–moving material in the core accumulates faster than normal, or the galaxy grows more slowly than usual, so that the break–through comes at an earlier stage, with less violent results. Such behavior is observed in a class of spiral galaxies, named after their discoverer as Seyferts, which are emitting energy at a rate "as much as 100 times the total emission of energy from an ordinary galaxy like ours," [87] mainly from a small central nucleus. It also appears that there are "periodic explosions in the Seyfert nucleus that blast debris into the surrounding regions." [88]

All of these observations are in accord with the tentative identification of the nature of the explosive process in the galaxies suggested by the presence of dense cores in the older galaxies. In the context of present–day astronomical theory, however, this explanation is ruled out by the absence of any known means of confining the fastmoving matter in the core of the galaxy. The answer to this problem was deduced from established facts in Chapter 6.

At the point where we have identified the quasars as the ultra high speed products of the galactic explosions that occur when the galaxies reach their evolutionary limit, and have confirmed the identification by a èomparison of properties, we have arrived at the observational limit. Our findings as to what happens to these objects beyond this stage cannot be verified by comparison with data from observation. But the fact that the results of successive additions of increments of speed, as deduced in the manner described in Chapter 6, are in full agreement with the observations as far as observation can penetrate is a strong indication that they are correct beyond this point as well.

On this basis, the net speed of the quasar continues to increase as the effect of gravitation is gradually eliminated, and ultimately it reaches the two–unit level. As noted in Chapter 6, this is the effective secter boundary. In the boundary zone the moving object is subject to influences of both the material and cosmic sectors. lt is still concentrated in space, and is therefore subject to spatial contacts and processes, but the gravitational effects are in time. The subsequent course of this object depends on the relative magnitudes of the opposing effects. Ordinarily gravitation prevails, and the quasar enters the cosmic sector, becoming unobservable.

The result of this exit of the quasars from the observational zone at a limiting net speed is to impose a rather sharp cut–off point on the quasar life span and redshift. The existence of this cut–off is recognized by the astronomers, but because they have not yet discovered the explosion speeds and their results, they attribute the cut–off to a different cause. As explained by Martin Ryle:

As we proceed outward… we find a great excess of fainter ones (radio sources)… But at still smaller intensities we find a sudden reversal of this trend – a dramatic reduction in the number of the faintest sources. This convergence is so abrupt that we must suppose that before a certain epoch in the past, there were no radio sources.[89]

This is another example of the “no alternative” fallacy that we have had occasion to criticize at several points in the preceding discussion. It is simply not true that we “must suppose” that there were no radio sources before a certain time. Like Einstein’s assertion that “there is no other way,” and other similar contentions that abound in present–day science, what such an assertion actually means is that there is no alternative *providing that all of the elements that define the situation to which the assertion applies are corremly apprehended*. But the theorist does not ordinarily resort to the “no alternative” argument unless his case is weak, and it usually turns out, in these instanees, that the general situation was not correctly interpreted. In the case now under consideration, analysis of observational data has indicated that all, or nearly all, of the most distant radio sources are quasars.[90] Our deductions from factual premises show (1) that these distant quasars are distributed two–dimensionally rather than three–dimensionally (corroborated by the studies just mentioned), and (2) that beyond the distance corresponding to the two–unit speed limit the quasars become unobservable.

Phenomena in the range between unit speed and unit energy, the intermediate regions, are unstable, in that they tend to advance, or revert back, to the lower energy, or speed, levels of the threedimensional regions. As noted earlier, the spatial forces sometimes gain the upper hand in the boundary zone, and cause a decrease in the speed, bringing the quasar or pulsar back into the material environment. Other explosion products, such as the white dwarfs, attain their maximum speeds in the intermediate range. The average speed of objects on the space side of the neutral axis, the material sector, is relatively low. Any object that leaves the boundary zone on the space side, or does not advance far enough to reach that zone, is subject to the environmental influences of the material sector, and it loses speed for this reason, gradually dropping back to a level below unit speed, in the region of three–dimensional space. Such objects return to the low speed range in essentially the same condition in which they left it. They have never ceased to be *material* aggregates.

Quasars or pulsars that attain speeds above two net units follow a totally different course. The significant change at the sector boundary is that gravitation, which is no longer effective in space because of the distance, becomes effective in time. This space–time reversal alters the factors that determine the stability of the aggregate. When gravitation begins operating in time, the individual atoms or stars that constitute the aggregate begin moving outward from each other in space by reason of the progression of the natural reference system, now no longer offset by inward gravitational motion. Coincidentally, the process of aggregation in time begins. Eventually the aggregate in space ceases to exist, and an aggregate in time takes its place.

We can deduce that the average energy in the sector of motion in time, the cosmic sector, is similar to the average speed in the sector of motion in space, in that it is relatively low, well below the unit level. The newly arrived atoms that were explosively ejected into this sector therefore lose energy in interactions with the environment. Eventually they drop below the unit energy level and into the region of threedimensional time.

As brought out in Chapter 5, the atoms of material aggregates, which are contiguous in space, are widely dispersed in time. Thus the continuous ejection of matter from the material sector by explosive processes causes a continuous inflow of dispersed matter into the cosmic sector. Under the influence of gravitation in time, this dispersed matter is gradually aggregated into cosmic stars, objects whose atoms are contiguous in time, but widely dispersed in space. The stars form clusters and galaxies in time,just as their counterparts do in space. Ultimately these aggregates reach the evolutionary limits at which they explode. Some of the explosions are violent enough to eject their products at energies that carry them across the boundary into the material sector. Here the process of aggregation of this matter, now widely dispersed in space, begins anew, initiating another cycle.

CHAPTER 8

Cosmological Conclusions

Any consideration of the large–scale structure and action of the universe such as that in Chapters 6 and 7 inevitably leads to questions as to how the universe originated, what its eventual fate will be, and how the physical processes that take place are related to the initial and final states. These are the primary concerns of the branch of knowledge known as cosmology. The study of the origin is separately classified as *cosmology*, but where so little information is available the separate classification is a nonessential refinement, and the present tendency is to apply the term cosmology to the whole field. In earlier times the only information bearing on cosmological issues was that claimed to have been derived by religious revelation, and therefore not open to scientific investigation. More recently some astronomical knowledge has been recognized as relevant, and at present scientific cosmology is regarded as a branch of astronomy.

Two general theories have emerged from the work of the astronomers. Both theories accept what is known as the *Cosmological Principle*, which asserts that the large–scale aspects of the universe appear the same from all locations in space. The *Steady–State* theory extends this to what the originators call the *Perfect Cosmological Principle*. This extension asserts that the large–scale aspects also appear the same from all locations in time. The *Big Bang* theory rejects this broader principle, and postulates an evolutionary development from an earlier to a later state. I n the simple theory these are initial and final conditions. A variation of the theory postulates a reversal at each end of this evolutionary path, leading to a never–ending oscillation between the two extremes.

Neither theory has more than a very few aspects that can be checked against observation, and both are therefore highly speculative. Their relative degree of acceptance has fluctuated as the small amount of relevant observational data has increased. At present the Steady State theory is at a low ebb, because its supporters have not yet been able to find acceptable explanations, within the theory, for some of the more recent observations. The results of this work indicate that such explanations exist, and if it were not for the fact that those results rule out the Steady State theory for other reasons, it could be put back on its feet again.

The crucial observation that any proposal must be prepared to explain (or explain away) is the recession of the distant galaxies. An explanation of the observed high degree of uniformity in space is also required, whether or not the Cosmological Principle is accepted. These items clearly have a direct relation to the pattern of evolution, whatever it may be. The status of the other items currently being offered as evidence is less critical. Much stress is being laid on the “bIack body” background radiation recently discovered, but it is difficu It to see why the ability of a theory to explain the existence of this radiation has any more significance than ability to explain any other currently obscure feature of the universe, the similar x–ray background radiation, for instance, or the cosmic rays, or the origin of galaxies, or any one of dozens of other items.

The ability of a theory to explain any one of these observed phenomena is a point in its favor, to be sure, but when there are so many other equally significant items that it *cannot* explain, it is clearly a gross exaggeration to brand this particular item as crucial. What has happened is that because neither theory can explain hardly anything, the significance of this one item that the
Big Bang theory has some kind of an explanation for has been blown up all out of proportion to its real importance. The sad fact is that while almost everything that happens in the universe is relevant to this issue in one way or another, none of the theories heretofore advanced has a broad enough base to enable it to deal with more than an insignificant number of these items.

The Big Bang theory assumes ad hoc that at some time in the past the entire contents of the universe were gathered together in a limited amount of space, and that a gigantic explosion occurred for some unspecified reason, ejecting all, or most, of these contents into space at the speeds that are now observed. It offers no explanation of the situation existing prior to the hypothetical explosion, or of the explosion process itself. It accepts the Cosmological Principle, but has no explanation of the uniformity that the principle requires. As noted earlier, the existence of the recently discovered background radiation, an explanation of which is provided by the theory, is not of major importance from the standpoint of verifying the validity of the theory, but it does give the Big Bang an edge over its current rival. The significance of this advantage is greatly exaggerated in current astronomical thought. The following comment from a 1980 publication is typical of the general attitude:

Why are we here taking for granted that there was a Big Bang origin of the Universe? The reason is that the existence of the 3K radiation field is incompatible with the steady–state theory.[91]

This so–called “reason” is totally illogical. The validity of a theory has to be established affirmatively; it cannot be proved by eliminating the *known* competitors, because no one can say how many unknown competitors may exist. Indeed, a number of alternative ideas, or variations of the two principal theories, have already been advanced. None of these has thus far received much support, but their existence is sufficient in itself to demonstrate the wide open nature of this issue.

Many efforts have been made to obtain affirmative support for an evolutionary type of theory, such as the Big Bang, by finding a difference in the density of some class of astronomical objects between those nearby and those at great distances. The radiation now reaching us from the most distant objects within observational range was emitted in an earlier era when the density, according to this type of theory, was greater than it is now. Some success in this endeavor is claimed on the basis of counts of radio sources. These appear to show that faint sources are more numerous than would be expected from a uniform distribution, tending to support the assertion that the sources have moved apart in the intervening time. However, the significance of the observations has been questioned because most, if not all, of the distant sources are quasars, and the astronomers' current understanding of these objects is too limited to give them much confidence in arguments based on assumptions about their properties. The information developed in the preceding chapter shows that this skepticism is well–founded, as it indicates that the assumption of a three–dimensional distribution, on which the density calculations are based, is not valid for the distant quasars.

The case in favor of the Big Bang theory (as distinguished from the case *against* its rival, the Steady State theory, which we will examine shortly) can be summarized as follows:

1. It is an explanation (a second–class explanation, we might say, as it is purely ad hoc) of the recession of the distant galaxies.

2. It is consistent with the observed large–scale uniformity of the umverse.

3. It produces an explanation for the black–body background radiation.

A similar summary of the case in favor of the Steady State theory consists of these items:

1. It is an explanation (likewise a second–class explanation, because it is lacking in detail) of the recession of the galaxies.

2. It is consistent with the large–scale uniformity of the universe.

3. It incorporates the space–time symmetry of the Perfect Cosmological Principle.

The most striking feature of both of these lists is how little they explain in covering such an immense subject area. As Verschuur sees the situation, "It is undoubtedly true that we know very little about the cosmological questions that have been posed so far."[92] As a resu lt , the case in favor of either theory is argued mainly on the basis of whatever points can be scored *against* its opponent. The lists of negative evidence are formidable. First, the Big Bang:

l. The fundamental premise of the theory is entirely ad hoc.

2. The theory offers no explanation of its basic elements. Neither the antecedents of the postulated explosion, the special conditions assumed to exist at the time of the event, nor the mechanism by means of which this event was initiated, is in any way accounted for.

3. The scale of the magnitudes involved is far out of line with experience, or even a reasonable extrapolation of experience.

4. No explanation is provided for the degree of isotropy now observed in the universe.

5. The theory provides no explanation for a large number of physical phenomena that are directly connected with the evolution of the hypothetical explosion products (aside from the background radiation).

6. Because of this lack of detail, it is untestable.

The case against the Steady State theory rests on these points:

1. The theory violates the conservation laws by requiring continuous creation of matter.

2. It provides no mechanism whereby the newly created matter can exert the force that is assumed to cause the outward motion of the previously existing matter.

3. It provides no mechanism for removing old matter from the system to keep the age distribution at the postulated constant level. (The oldest galaxies are presumed to disappear over the "time horizon," but even if this is considered to remove them from the universe – an assumption that rests on rather shaky ground – it serves the purpose only until the galaxy from which the time horizon is observed becomes the oldest. Thereafter, the age of the oldest galaxy in the observable system continually increases.)

4. It provides no explanation for a large number of physical phenomena (including the background radiation) that are directly connected with the evolution from diffuse newly created matter to old receding galaxies.

5. Because of this lack of detail, it is untestable.

It is clear that the evidence in support of either of these theories is ridiculously inadequate for verification. But because of the tendency to pass judgment on the basis of the arguments against one or the other, which are strong in both cases, the recent discovery of the background radiation haš tipped the balance in favor of the Big Bang. The prevailing attitude in astronomical circles is described by Jay Pasachoff in these words:

So at present almost all astronomers consider it settled that radiation has been detected that could only have been produced in a big bang.[93]

This is a particularly outrageous example of the "This is the only way" fallacy discussed in Chapter 3. It assumes first that since the background radiation *has not been* explained in terms of the Steady State theory, it *cannot be* so explained. This is pure nonsense. It should be obvious that no one is in a position to say what is impossible for an open–ended theory of this kind. There is still less justification for the assumption, likewise implicit in the conclusion, that no other tenable cosmological theory is conceivable.

Some observers do see the weaknesses in the case for the Big Bang, and take a more cautious stand, as in the following statements:

Even if this general picture (the Big Bang) seems consistent with what is known at the moment, it would be rash to bet *too* heavily on it being correct, even in outline.[94] (Martin Rees)

No one acquainted with the contortions of theoretical astrophysicists in the attempt to interpret the successive observations of the past few decades would exhibit great confidence that the solution in favor of the hot big bang would be the final pronouncement in cosmology.[95] (Bernard Lovell)

In any event, the "no other way" argument is immediately and totally demolished when, as in this case, the allegedly impossible alternative is actually produced. Emphasizing the absurdity of the "only way" argument, it also turns out that the alternative explanation of the background radiation supplied by the present development was previously suggested by Fred H oyle as a means by which that radiation could be accommodated within the Steady State theory. Hoyle's suggestion, admittedly ad hoc and given scant attention by his adversaries, was that the background radiation comes from an unseen region of the universe.[96] This is essentially the same conclusion reached deductively from factual premises in this work.

The new factual information derived from the scalar motion investigation, and reported in the preceding pages of this volume, now enables us to put together a factual alternative to the existing unsatisfactory cosmological theories, a new *undersranding*, we may call it, to distinguish it from a theory. Cosmological questions have been in the realm of speculation and theory for so long a time that it may be hard for many individuals (particularly astronomers) to believe that some of the most significant of these issues can now be approached as matters of fact. Yet even a casual consideration of the conclusions derived from purely factual premises in the preceding pages will show that they go directly to the heart of major cosmological issues. The Big Bang, for instance, is automatically ruled out by the finding that the galactic recession originates from a different cause. Other facts disclosed by the scalar motion study, and the necessary consequences of those facts, similarly serve as guideposts by which we can trace the evolutionary path that the contents of the universe actually follow. The path thus defined differs in many respects from the course of events portrayed in present–day astronomical theory, but it is in full agreement with the results of *observation*, as a purely factual development necessarily must be.

Let us now review the principal factual findings that are pertinent to the cosmological issues.

1. Because of the reciprocal relation between space and time in scalar motion, there is an inverse sector of the universe in which motion takes place in time rather than in space. All scalar motion phenomena in three–dimensional space are thus duplicated in the cosmic sector, the sector of motion in time.

2. There is a limiting size for galaxies, and at least some of those that reach this limit explode, ejecting fragments, known as quasars, at speeds in the ultra high range, between two and three times the speed of light.

3. When the retarding effect of gravitation is reduced enough by distance to bring the *net* speed of a quasar above two units (twice the speed of light) the gravitational effect inverts, and the constituents of the quasar are dispersed into three–dimensional time (the cosmic sector of the universe).

4. The effect of the explosion and its aftermath is to transform a cluantity of matter from a state in which it is highly concentrated in space to a state in which it is widely dispersed in time.

5. By reason of the reciprocal relation between space and time in scalar phenomena, it follows that the inverse of the foregoing processes likewise take place, the net effect of which is to transform a quantity of matter from a state in which it is highly concentrated in time to a state in which it is widely dispersed in three–dimensional space.

We thus find that there is a constant inflow of widely dispersed matter into the material sector from the cosmic sector. It seems rather obvious that this incoming matter can be identified with the cosmic rays, but this identification is not necessary to the development of thought in the subsequent pages. The essential point is that this inflow of matter takes place in *some* dispersed form.

We have thus identified, on a purely factual basis, the initial state of matter in the material sector of the universe, the sector accessible to observation. This matter arrives in the form of basic units, which we can identify as atoms and sub–atomic particles. We have similarly identified the final state of matter in the material sector as highly concentrated spatially in massive galaxies. It follows that the *essential* process in this sector, the process by which matter is brought from the initial state to the final state, is a process of aggregation.

We know from observation that there are three such aggregation processes. Some of the sub–atomic particles and primitive atoms combine to form larger atoms (atoms of heavier elements). The dispersed material condenses into stars, incorporating whatever heavy elements have formed up to the time of condensation. The stars then aggregate into clusters and galaxies, while the other two processes continue. It will be convenient to examine these processes in the reverse order.

According to our findings, the agency by means of which the aggregation takes place is gravitation. On this basis, the evolutionary stage is indicated by the size of the aggregate. It follows that the smallest self–sufficient stellar aggregate, the globular cluster, is the initial product of the aggregation process, and the various types of galaxies follow in the order of size.

Here we come into direct collision with current astronomical theory. The current belief is that the galaxies were formed directly from the original material of the universe in approximately their present form, and are all about the same age. Jastrow and Thompson give us this explanation:

According to current ideas in astrophysics, the galaxies were born first in the universe, and the stars within the galaxies were born afterward. The main reason for believing this to be true is the fact that stars can be seen forming in galaxies at the present time, out of gas and dust. If all the stars were formed first, and then were clustered together later to form the galaxies, there would be no star formation going on today.[97]

Most astronomers are apparently convinced that stars are forming in certain locations in the galaxies, as indicated in this statement, but, as many of them have pointed out, there is no actual evidence to support this belief. I.S. Shklovskii, for instance, characterizes the "star formation problem"as still in the "realm of pure speculation."[98] Simon Mitton says that it is "almost a total mystery."[99] And even if there is *some* star formation in these locations in the galaxies, there certainly is no evidence that this process accounts for all, or even any more than a small portion, of the total star formation. Thus the conclusion expressed in the foregoing quotation is no more than speculative.

The process of galaxy formation is even more speculative than the star formation process. W. H. MeCrea points out that "We do not yet know how to tackle the problem."[100] Laurie H. John gives us this assessment of the present situation:

The encyclopaedias and popular astronomical books are full of plausible tales of condensation from vortices, turbulent gas clouds and the like, but the sad truth is that we do not know how the galaxies came into being.[101]

Two recent developments have eroded what little support the current ideas about galaxy formation were able to claim at an earlier stage of observational knowledge. First is the growing evidence of galactic "cannibalism." M. J. Rees points out that the prevailing ideas are inconsistent with the new information. "One may not bejustified in considering a galaxy as a self–contained isolated system," he says, and cites some of the evidence:

We can see many instances where galaxies seem to be colliding and merging with each other, and in rich clusters such as Coma the large central galaxies may be cannibalizing their smaller neighbors… Maybe in a few billion years this fate will affect our own Milky Way and the Andromeda galaxy, transforming the local group into a single amorphous elliptical galaxy. Many big galaxies – particularly the so–called CD galaxies in the centres of clusters – may indeed be the resu It of such mergers. [102]

The second discovery of recent years that has a bearing on this situation is the abundance of small elliptical and irregular galaxies. Most observations of galaxies have been made on the larger objects, because only the nearest of the small galaxies are visible. The large number of additional dwarf galaxies discovered within the Local Group quite recently, increasing the already high ratio of elliptical to spiral in the region most accessible to observation, has emphasized the extent to which previous conclusions have been shaped by this selection effect. It is now beginning to be realized that, as noted in a 1980 news item, the dwarf ellipticals "may be the most common type of galaxy in the universe."[103]

The significance of the abundance of these dwarf galaxies, containing from a million to perhaps 100 million stars of the same type as those in the globular clusters, is that it closes the gap between galaxy and cluster. There is now no valid reason for regarding these as two different classes of objects. "We see that there is no absolutely sharp cutoff distinguishing galaxies from globular clusters,"[104] admits Harwit. The globular cluster, too, is a galaxy; a galaxy, junior grade, we may say. Thus, these clusters are the original stellar aggregates, from which the larger galaxies are formed by the capture process.

In addition to fitting into the overall aggregation process of the material sector in a natural and logical way, the identification of the globular clusters as the original products of the star formation process carries with it the identification of the nature of the process, the key element that has been lacking in previous attempts to explain the origin of the stars. The description of the structure of the globular clusters in Chapter 6 is equally applicable to the pre–cluster cloud of dust and gas. If we consider successively larger spherical aggregates of dispersed matter, the particles of this matter are subject to the same motions (forces) as the stars in the clusters. The individual particles are moving outward away from each other by reason of the progression of the natural reference system. Coincidentally they are moving inward toward each other gravitationally, and also inward toward the center of the aggregate under the gravitational influence of the aggregate as a whole. In the central regions of this aggregate, the net motion is outward, but the gravitational effect on the outer particles inereases with the radius of the sphere, and at some very large distance, the inward and outward motions reach equality. Beyond this distance, the net motion is inward. As in the star cluster, the resu It is an eyuilibrium between the inward motion of the outer particles and the outward motion of the inner particles.

While the end result of this process is an equilibrium, not a condensation, the action does not stop at this point. It was brought out in the preceding chapter that there is a continuous inflow of matter from the cosmic sector of the universe. This matter is dispersed throughout all of the space of the material sector, and the mass contained within the equilibrium system is therefore slowly increased. This strengthens the gravitational forces, and initiates a contraction of the aggregate. Once begun, the contraction is self–reinforcing and it continues at an accelerating rate. Meanwhile, some subsidiary concentrations of matter form within the aggregate, and since these leave increasing amounts of vacant space, the original aggregate separates into a large group of sub–aggregates. Eventually, the subaggregates become stars, and the aggregate as a whole becomes a globular cluster.

This initial phase of the aggregation process is unobservable, and cannot be verified directly. There is, however, an increasing amount of evidence indicating that very large dust clouds are being pulled into the Galaxy. A rather obvious explanation of these clouds (the only one that has appeared thus far) is that they are unconsolidated globular clusters, aggregates of the kind that we have been discussing, that have been captured before they have had time to complete the condensation process.

Condensation of the aggregates that escape this fate should produce a large population of globular clusters scattered throughout inter–galactic space. This is another conclusion that cannot be verified observationally, as matters now stand, although individual clusters have been located as far out as 500,000 light years. But if the clusters are as plentiful as the foregoing conclusions would indicate, a substantial number of them should be in the process of being pulled in to the galaxies.

Here we come within the observational range, and we find full agreement. The number of globular clusters surrounding a galaxy is a funetion of the galactic mass, as would be expected if the clusters were originally distributed somewhat uniformly in the environment. There are a few clusters accompanying the small member of the Local Group located in Fornax, two dozen or more in the Large Magellanic Cloud, our own Milky Way galaxy has about 200, NGC 4594, the “Sombrero,” is reported to have several hundred, while the number surrounding M 87, the giant of our neighborhood, is estimated at from one to two thousand. These numbers of clusters are definitely in the order of the galactic masses.

In all of the large galaxies, the clusters are located in symmetrical patterns similar to the distribution around our own galaxy, which is a roughly spherical distribution around the galactic center. These clusters do not participate, to any significant extent, in the rotation of the galaxy. I nstead, as reported by Struve, they move “much as freely falling bodies attracted by the galactic center.”[105] This isjust what they are, according to our new findings.

Even though all of the available information as to the nature and properties of the *clusters* is in agreement with this conclusion, it will be regarded by the astronomers as outrageous, because it conflicts with their current beliefs as to the ages of the *stars* of which the clusters are composed. The ironic feature of the situation is that the *astronomical* evidence of age is fully in accord with the conclusion of this present investigation that the stars of the globular clusters are the youngest of the observable stars. But the astronomers reject the observational evidence from their own field in order to accommodate their theories to an *assumption* that has been made by the physicists.

This crucial assumption concerns the nature of the process by which energy is generated in the stars. Although most of their assertions sound fully confident, the physicists do not claim that they actually *know* what this process is. W hen they want to be careful not to overstate their case, they say something like the following from an article entitled “The Energy of the Stars,” by Robert E. Marshak, “So we can safely assume that the stars produce energy by the combination of light elements through the collisions of their swiftly moving nuclei.”[106] No matter how “safe” an assumption may be, it is still an assumption, not a fact, and it cannot legitimately be treated as an incontestable fact in the way in which the astronomers are now using it.

The assumption seems “safe” to the physicists only because they see no alternative at the moment. In itself, the assumption involves an extrapolation of the kind characterized by Bridgman as “perfectly hair–raising.” Even in a day when hair–raising extrapolations are somewhat commonplace, this one sets some kind of a record. In view of the gigantic extrapolation that is required to pass from the relatively insignificant temperatures and pressures that we deal with on earth to the immensely greater magnitudes which we believe (also on the strength of extrapolation) exist in the stellar interiors, even the thought that the answers thus obtained *might* be correct calls for the exercise of no small amount of faith in the validity of theoretical procedures. Any contention that the extrapolated results constitute firm knowledge is simply preposterous.

Nevertheless, this “safe” assumption would certainly be acceptable on a tentative basis (the highest status that can legitimately be accorded to *any* assumption), in spite of its lack of tangible support, if it agreed with all of the relevant empirical information from astronomical sources. But the truth is that in almost all cases where a meaningful comparison can be made, this assumption *conflicts* with the astronomical observations.

One very significant point is that the physicists' process is not powerful enough to meet the astronomers' requirements. Even before the extremely energetic compact objects were discovered, leading astronomers were asserting that "a more powerful source of energy must be assumed"[107] in order to account for the emission from the blue giant stars. The recent discoveries have exacerbated the problem, as many of the new objects are emitting energy at prodigious rates. W ith respect to one of these, Jastrow and Thompson make this comment:

Pound for pound, the Seyfert galaxy may be emitting as much as one hundred times more energy than our Galaxy. Even more so than in the case of M 82, this energy release seems difficu It to explain in terms of nuclear reactions in stars."[87]

If the energy of the stars is generated by the conversion of hydrogen to successively heavier elements in accordance with the physicists' hypothesis, the hot massive stars at the upper end of the main sequence must be young, inasmuch as their supply of hydrogen would yuickly be exhausted at the present rate of energy output. But this conclusion that the most massive and energetic of all stars are young and short–lived is an inherently improbable hypothesis, and the astronomers recognize this, even though they are reluctant to implement their calls for a "radical revision of the laws of physics"[77] by challenging this *particular* conclusion reached by the physicists. "It is no small matter to accept as proven the conclusion that some of our most conspicuous supergiants, like Rigel, were formed so very recently on the cosmic scale of time measurement,"[108] X Bart J. Bok tells us.

There are good reasons for the skepticism revealed in this statement. As Bok evidently realized, at least vaguely, the association of product with process in incongruous. No one is suggesting that ordinary stars are products of catastrophic processes. Even those who place the principal star formation in the early stages of a Big Bang universe envision the stars as being produced by condensation of dust clouds. Furthermore, the only dust clouds available for star formation in the *current* stage of the universe (if there ever were any earlier stages) are *cold* dust clouds. The initial product of condensation must therefore be a cool star.

This point is conceded by those who have undertaken to develop the details of the star formation process. These investigators realize that star formation is not a catastrophic process. Such processes are destructive. They may produce some new combinations of the previously existing basic units, but these are no more than fragments. The *general* effect of such a process is to disintegrate whatever structure or structures were involved in the event. Natural building processes, on the other hand, are slow and gradual. In star formation, the dust cloud must first pass through a stage in which it is some kind of a cool and diffuse "protostar," and then gradually evolve into a stage in which it has the characteristics of a normal star. The very nature of the production of a hot massive star from a cool dust cloud thus requires it to be a slow cumulative process extending over a long period of time.

The existence of a mass limit at which some or all stars undergo explosive processes also argues strongly against the hypothesis that the massive stars are young. A limit normally marks the end of a process, not the beginning. It implies the existence of a previous process of addition of the limited yuantities, in this case, mass and temperature. All of the foregoing considerations point in the same direction. They all agree that the cool stars newly emerged from the protostar stage are young, and the hot massive stars, together with other classes of stars that have reached equilibrium states, are old.

The observed abundances of the heavier elements in the various classes of stars likewise support the finding that the present views as to the stellar age sequence are wrong. The present astronomical ideas based on the physicists' energy generation assumption lead to a situation in which old clusters of old stars are composed of young (that is, unevolved) matter. This is clearly another inherently improbable combination.

An ingenious theory has been devised by the astronomers to account for this strange state of affairs. On the basis of the physicists' hypothesis, the processes under way in the central regions of the stars are atom–building processes, and it is assumed that the build–up continues far enough to produce heavy elements, or "metals." According to the theory, these metals are ejected into the environment in the supernova explosions, enriching the metal content of the interstellar dust. It follows, so the theory goes, that the stars formed early in the history of the universe, those of the globular clusters, for example, were produced from matter of low metal content, whereas those formed more recently, such as the stars of the galactic arms, were produced from matter of relatively high metal content. Although this theory is the current orthodoxy, it is conceded that there are some embarrassing conflicts with observations. For example, Ivan R. King points out that

All the stars that we know, no matter how old, have some amount of heavy elements in them. Where did these heavy atoms come from?[109]

Also, some globular clusters conttain appreciable amounts of hot stars, a fact that is very disturbing to supporters of current theories. Struve, for instance, called the presence of these hot stars an "apparent defiance" of modern stellar evolutionary theory.[110] The same problem arises from the presence of unevolved, and therefore presumably young, material in some clusters. Helen S. Hogg makes this comment in an article in the Encyclopedia Brittanica:

Puzzling features in some globular clusters are dark lanes of nebulous material…it is difficu It to explain the presence of distinct, separate masses of unformed material in old systems. [111]

Of course, the conclusion reached in the present investigation, which finds the globular clusters to be young aggregates of young stars composed of young matter, has the inverse task of accounting for the presence of old stars in these young aggregates, but this is no problem, since the region of space in which the cluster condenses from dispersed material inevitably contains some of the old stars of the low speed components of the galactic explosion products, and these are gathered in during the condensation process.

Some recent observations of the stars of the central regions of the Galaxy offer a direct challenge to the prevailing belief as to the association of low metal content with age. For example, a 1975 review article reports measurements indicating that the "dominant stellar population in the nuclear bulges of the Galaxy and M 31 consists of old metal–rich stars."[112] As the author points out, this reverses previous ideas, the ideas that are set forth in the textbooks. The term "old metalrich stars" is, in itself, a direct contradiction of current theory. Harwit comments on this situation as follows:

There also seems to exist abundant evidence that the stars, at least in our Galaxy and in M 31, have an increasingly great metal abundance as the center of the galaxy is approached.[104]

Any systematic change in composition "as the center of the galaxy is approached" favors the aggregation explanation of galaxy formation, which identifies the central regions as the oldest part of the galaxy. The increasing metal content is thus correlated with increasing age, as our findings indicate.

Observations that define the evolutionary pattern of the clusters produce some equally conclusive evidence, not only of the validity of the reversed age seduence, but also of the participation of the globular clusters in the aggregation, or cannibalism, process of galaxy building. Globular clusters closer to the galactic center are found to be smaller than those farther out. Studies indicate a difference of 30 percent between 10,000 and 25,000 parsecs.[113] If the current explanation of the movement of the clusters in "elongated orbits" were correct, the present distance from the galactic center would have no significance, as a cluster could be anywhere in its orbit. The existence of a systematic difference between the closer and more distant clusters shows that the clusters are approaching the Galaxy, and are losing mass by reason of the differential gravitational effect as they approach. This confirms the conclusion that they are on the way to capture, and are not old features of the Galaxy, as viewed by present–day astronomical theory.

During the time that these clusters are moving toward the Galaxy there is a systematic inerease in the metal content. "The farther a (globular) cluster star is from the center of the galaxy, the more deficient it seems to be in heavy elements,"[114] says Iben. Bok and Bok elaborate on this point:

There seem to be rather marked differences in chemical composition between the central group (of globular clusters) and the outlying clusters. The latter seem to be generally metal–poor in their spectra, whereas metallic lines do show up more prominently in the spectra of the clusters found close to the center of our Galaxy.[115]

There is another class of star clusters in the Galaxy, much smaller than the globular clusters, and much more numerous, numbering as many as 40,000 by some estimates. They are much closer to the galactic plane than the globular clusters, and can be considered as being located in the Galaxy, rather than *around* it. These clusters, the *galactic*, or *open*, clusters, are expanding at measureable rates, and can therefore have only a relatively short life before their constituent stars merge with the general background population. It follows that there must be some process in operation that continually replenishes the supply.

The astronomers have been unable to find such a process. Like other members of the human race, they are reluctant to admit that they are baffled, so the general tendency at present is to assume that the open clusters must originate in the course of the star formation process that is believed to be taking place in dense galactic dust clouds. But this conclusion simply cannot stand up. If the cohesive forces in these clouds are strong enough to *form* a cluster, they are certainly strong enough to *maintain* it. Those who do face the issue therefore recognize that current theory has no satisfactory answer to the problem. Bok and Bok, who discuss the question at some length, conclude that at least some classes of clusters are *not* being replaced. The most conspicuous clusters, the Pleiades, Hyades, etc., are disintegrating, and these authors say "there seem to be no others slated to take their place." Likewise they conclude that the "open clusters with stars of spectral type A and later… may be a vanishing species."[116]

In the context of the new understanding of the place of the globular clusters in the evolutionary scheme described in this volume, there are no such difficulties. The globular clusters that are approaching from all directions will ultimately fall into the Galaxy, where they will be broken up into smaller units by the rotational forces. Bok and Bok concede that "one might be tempted to think about dismembered globular clusters as possible Pleiades–like clusters," but since this conflicts with the prevailing ideas about stellar evolution, they dismiss this "tempting" thought as impossible. The physicists' assumption as to the nature of the energy production process must be supported, whatever the cost.

As noted above, the open clusters are expanding at rates that are rapid enough to be measured. Here, then, is one of the rare places in astronomy where the direction of evolution can be unequivocally determined from direct observation. As the cluster ages, the density decreases because of the expansion. Studies have been made of the cluster density, and it has been found that the average open cluster currently classified as "old" (example – M 67) has a higher density, and is located higher above the galactic plane, than the average open cluster currently classified as "young" (example – the double cluster in Perseus).[117] Because of the expansion effect, we can identify the clusters with the greater average density (the M 67 type) as the younger, and those with the lower average density (the Perseus type) as the older. This is just the opposite of the present "official" view, which, as has been pointed out, rests entirely on a curiously unquestioning faith in the currently popular theory of the stellar energy generation process.

Current astronomical theory regards all, or at least most, of these open clusters as having originated in the spiral arms. The present locations of the M 67 class, well away from the assumed place of origin therefore pose a problem. The following is an example of the kind of "explanation" that is currently being offered for this anomaly:

Older (open) clusters, whose Main Sequence does not reach to the blue stars, show no correlation with spiral arms because in the intervening years their motions have carried them far from their place of birth.[118]

These star clusters are not where we would expect to find them, on the basis of the accepted theory of their origin, so it is simply assumed that they must have moved. A systematic motion of an entire class of objects *against* the gravitational force gradient, and not in the direction of the rotational forces – a most improbable happening– is casually offered as something that we can accept without any question. Even in the absence of the definite identification of the direction of evolution provided by the relative densities of the expanding clusters, it should have been evident that the lack of "correlation with the spiral arms" is a contradiction of accepted views that cannot be resolved by an unsubstantiated assumption.

Our new findings as to the relative ages of the two classes of open clusters are in agreement with the conclusions previously reached as to the relation of metal content to age, and as to the origin of the open clusters from globular clusters that fall into the Galaxy. M 67, now seen to be one of the youngest of these clusters, is one of the highest above the galactic plane, indicating that it is still falling, as would be expected if it is a fragment of a comparatively recent arrival. Furthermore, the H–R diagram of this cluster, which indicates its stellar composition, is almost identical with that of a late type globular cluster, such as M 13, whereas the stars of the open clusters that are now seen to be older, are mainly main sequence stars, comparable to the general population in their environment.

There is now a consistent evolutionary pattern all the way from the most remote globular cluster to the most advanced open cluster, a pattern that fits in comfortably with the concept of continuous galactic aggregation that is required by our findings, and is gradually making its way into astronomical thought as more and more evidence of cannibalism is accumulated. The most distant globular clusters that are observed are relatively large, and have a very small content of heavy elements (as little as 0.1 percent of the solar abundance, according to some estimates).[119] As the clusters are pulled slowly in toward the Galaxy gravitationally, the atom–building processes that are under way in all matter inerease the proportion of heavy elements, while at the same time the differential gravitational effects reduce the cluster mass. A more mature cluster in the immediate vicinity of the Galaxy is thus smaller, but has increased its metal content to a substantial fraction of the solar abundance.

Disruption of the cluster on entry into the galactic disk does not alter the composition, and the clusters of the M 67 type therefore have essentially the same metal abundances as the late type globular clusters. As the open clusters age, the metal abundance continues to inerease, and the oldest of these clusters reach levels comparable to those of the general field stars in the environment. As indicated earlier, this is not the end of the atom–building process. The still older stars in the central regions of the Galaxy have a still greater metal content.

The factual information thus far available does not define the nature of the process by which the heavier elements are bui It up, except that it requires this process to be one that operates continuously throughout the existence of matter in the material sector. This rules out processes such as the currently favored high temperature reactions in the central regions of the stars, and it suggests some kind of a capture process. Neutrons are readily absorbed under almost any conditions, and may play the dominant role. For present purposes, however, all that we need to know is that such a process exists, a fact that is demonstrated by the observed results.

The information presented in the foregoing pages should be more than sufficient to show that the conclusion as to the nature of the aggregation process from sub–atomic particle to giant galaxy that has been derived from factual premises is fully in accord with the relevant *facts* disclosed by astronomical observation, even though it conflicts with some of the *beliefs* that currently prevail in astronomical circles. The reciprocal relation between space and time then assures us that the same kind of an aggregation process is taking place in the cosmic sector of the universe. The large–scale action of the universe can thus be summarized in this manner:

Location	Process	Final State
3–dimensional space	aggregation	concentrated in space
Intermediate region	ejection	dispersed in time
3–dimensional time	aggregation	concentrated in time
Intermediate region	ejection	dispersed in space

Here in a nutshell is the cosmological understanding at which we arrive by developing the necessary consequences of the new factual information uncovered in the course of the scalar motion investigation. These results show that the large–scale action of the universe is *cyclic*. The final products of the major aggregation processes of the material sector are ejected, pass through the intermediate, or transition, zone, and enter the cosmic sector, where they become the primitive entities of that sector. The final products of the major aggregation processes of the cosmic sector are similarly ejected back into the material sector, and become the primitive entities of that sector.

This is a steady state universe, but unlike the universe contemplated by the theory that goes by that name, it faces no problem in obtaining its raw material, or in disposing of its end products. The raw material does not have to be created in defiance of the conservation laws. It is continually being supplied from the inverse sector, and that sector is constantly available to receive the processed material.. The new understanding thus retains the desirable characteristics of the Steady State theory without its disadvantages. At the same time, it provides the key feature of the Big Bang theory, an explanation of the recession of the distant galaxies, and does so directly from the inherent nature of scalar motion, eliminating the need for any implausible ad hoc assumption such as the Big Bang.

We do not have the option of accepting or rejecting physical facts, or the necessary and unavoidable consequences thereof, as we do conclusions based on theories or assumptions. It is therefore superfluous to present a “case in favor” of the factual understanding that has just been derived, but the redundancy involved in so doing appears to be worthwhile as a means of emphasizing the difference between the results of a factual development and those of theories based on speculative assumptions. The points in favor of this new understanding can be summarized as follows:

1. There is nothing ad hoc in this understanding, nor does it depend in any way on theoretical premises. All conclusions have been derived from established facts and their necessary conseyuences.

2. *All* of the points listed in favor of either of the two current theories are equally applicable to the understanding described herein.

3. None of the points listed as objections to either of these current theories is applicable to this new understanding.

Some comment probably needs to be made concerning item number 3 in the list of objections to the Big Bang theory, which involves *postulating* phenomena on a scale immensely greater than anything now known. It may perhaps be argued that the new understanding is doing the same thing in asserting the existence of speeds much greater than that of light. The answer to this is that this extension of the speed limit is not an assumption. It comes from a newly discovered fact: the existence of scalar motion in three dimensions. Since it is already known that speeds approaching the speed of light can be attained in the one scalar dimension capable of representation in the conventional spatial reference system, the factual finding that motion can take place in three such dimensions automatically raises the limiting magnitude of the total speed to three times the speed of light.

It is particularly significant that this new understanding is not subject to item number 5 in the list of objections to the Big Bang theory. It is a broad–based set of established facts, and consequences thereof, that leads to many conclusions in many fields of science, as indicated in the preceding pages of this volume. The broad scope of these findings unites cosmology not only with astronomy, but also with physics, a nd provides a host of opportunities for correlation with reliable data from observation.

Turning now to the objections that can be raised against the new understanding, we find the following:

1. This understanding is new and unfamiliar.

2. It applies only to the *physical* universe, not necessarily to all existence.

3. It does not explain the origin and eventual fate of the universe. The first of these objections can be overcome in time. Whether or not it will be possible to extend our investigations into the areas to which the other two items refer is not indicated by the facts developed in the scalar motion study. Invalidation of the view of space and time as a *container* for all that exists leaves open the possibility that there may be existences other than the physical universe, but the facts developed herein have relevance only to that universe.

The more that has been learned about the physical universe, the more evident it has become that we are learning only what it *is* and what it *does*. There is nothing in this information to give us any clue as to how it originated, or, indeed, whether it had an origin. As it appears in the light of the findings of the scalar motion investigation, the physical universe is an existing, self–contained, and self–perpetuating mechanism. Perhaps it was created. Perhaps it may eventually be destroyed. But creation, if it took place, must have been accomplished by agencies outside the physical universe itself (as the advocates of creation contend). Likewise there can be no destruction unless some outside agency intervenes. In the absence of such intervention, the physical universe will continue operating indefinitely, without any significant change in its large–scale aspects.

References

1. Butterfield, Herbert, *The Origins of Modern Science,* Revised Edition, The Free Press, New York, 1965, page 19.
2. Hulsizer and Lararus, *The World of Physics*, Addison-Wesley Publishing Co., Menlo Park, Cal., 1977, page 2.
3. *Physical Science Today*, CRM Books, Del Mar, Cal., 1973, page 90.
4. Andrade, E.N. daC., *An Approach to Modern Physics*, G. Bell & Sons, London, 1960, page 10.
5. Gardner, Martin, *The Ambidextrous Universe*, Charles Scribner's Sons, New York, 1979, page 200.
6. Feynman, Richard, *The Feynman Lectures on Physics*, *Volume I*, Addison-Wesley Publishing Co., Reading, Mass., 1963, page 12-2.
7. Wightman, W.P.D., *The Growth of Scientific Ideas*, Yale University Press, 1953, page 102.
8. Einstein, Albert, Foreword to *Conceprs of Space*, by Max Jammer, Harvard University Press, 1954.
9. Einstein and Infeld, *The Evolution of Physics*, Simon & Schuster, New York, 1938, page 185.
10. *Ibid*., page 158.
11. Einstein, Albert, *Relativity*, Henry Holt & Co., New York, 1921, page 74.
12. Walker, Marshall, *The Nature of Scientific Though*, Prentice-Hall, Englewood Cliffs, N. J., 1963, page 125.
13. Park, David, *Conremporary Physics*, Harcourt, Brace & World, New York, 1964, page 123.
14. *Ibid*., page 52.
15. Heisenberg, Werner, *Philosophic Problems of Nuclear Science*, Pantheon Books, New York, 1952, page 38.
16. Bridgman, P. W., *Reflections of a Physicist*, Second Edition, Philosophical Library, New York 1955, page 169.
17. Wooldridge, Dean E., *The Machinery of Life*, McGraw-Hill Book Co., New York, 1966, page 4.
18. Dicke, R. H., American Scientist, March 1959.
19. Science News, Jan. 31, 1970.
20. Von Laue, Max, *Alben Einstein: Philosopher-Scientist*, edited by Paul A Schilpp, Tudor Publishing Co., New York, 1951, page 517.
21. de Vaucouleurs, G., Science, Feb. 27, 1970.
22. Lindsay, R. B., Physics Today, Dec. 1967.
23. Einstein, Albert, *Albert Einstein: Philosopher-Scientist, op. cit*., page 21.
24. Feynman, Richard, *op. cit.*, page 7-9.
25. Gerholm, Tor R., *Physics and Man*, The Bedminster Press, Totowa, N.J., 1967, page 135.
26. Bergmann, Peter G., Reviews of Modern Physics, Oct. 1961.

27. De Witt, Bryce, Science, Nov. 16, 1973.
28. Gerholm, Tor R., *op. cit.*, pages 147, I51.
29. Lovell, Bernard, *In the Center of Immensities*, Harper & Row, New York, 1978, page 17.
30. *Ibid*., page 113.
31. Sciama, Dennis, *Cosmology Now*, Edited by Laurie John, Taplinger Publishing Co., New York, 1976, pages 100, 101.
32. Feynman, Richard, *The Character of Physical Law*, MIT Press, 1967, page 30.
33. Robinson, F. N. H., *Encyclopedia Brittanica*, 15th Edition, Vol. 6, page 543.
34. Shapley, Harlow, *Of Stars and Men*, Beacon Press, Boston, 1958, page 63.
35. Black, Max, *Critical Thinking*, Second Edition, Prentice-Hall, New York, 1952, page 354.
36. Einstein and Infeld, *op. cit.*, page 195.
37. Millikan, R. A., *Time and Its Mysteries*, Collier Books, New York, 1962, page 24.
38. Bronowski, J., *The Common Sense of Science*, Harvard University Press, 1953, page 74.
39. Millikan, R. A., *Evolution in Science and Religion*, Yale University Press, 1928, page 10.
40. Hoyle, Fred, *From Stonehenge to Modern Cosmology*, W. H. Freeman & Co., San Francisco, 1972, page 62.
41. Laporte, Otto, quoted in Heisenberg, *Physics and Beyond*, Harper & Row, New York, 1971, page 30.
42. Dirac, P. A. M., Scientific American, May 1963.
43. Hanson, Norwood, *Scientific Change*, edited by A. C. Crombie, Basic Books, New York, 1963, page 492.
44. Lindemann, F. A., *The Physical Significance of the Quantum Theory*, The Clarendon Press, Oxford, 1932, page 14.
45. Einstein, *Albert, Albert Einstein: Philosopher-Scientist, op. cit.*, page 67.
46. Heisenberg, Werner, Physics and Philosophy, Harper & Row, New York, 1958, page 129.
47. Bridgman, P. W., *op. cit.*, page 186.
48. Shortley and Williams, *Elements of Physics*, Prentice-Hall, New York, 1955, page 830.
49. Jeans, James, *Physics and Philosophy*, The Macmillan Co., New York, 1945, page 190.
50. Whitehead, Alfred N., Science and the Modern World, New American Library, New York, 1948, page 48.

51. Reichenbach, Hans, Alberr Einseein: Philosopher-Scientist, op. cit., page 290.

52. Hesse, Mary B., Forces and Fields, Philosophical Library, New York, 1962, page 253.

53 Gödel, Kurt, Alben Einstein: Philosopher-Scientist, op. cit., page 557.

54. Weaver, Warren, Science and Imagination, Basic Books, New York, 1967, page 50.

55. Ibid., page 99.

56.Northrop, F. S. C., The Logic of the Sciences and the Humanities, Meridian Books, New York 1959, page 61.

57 Ibid., page 37.

58 Einstein, Albert, The Structure of Scientific Thought, edited by Edward H. Madden, Houghton Mifflin Co., Boston, 1960, page 82.

59 Einstein, Albert, The World As I See It, Covici Friede, New York, 1934, page 91.

60 Feynman, Richard, The Character of Physical Law, op. cit., page 55.

61 Tolman, Richard C., The Theory of the Relativity of Motion, University of California Press, 1917, page 27.

62 Lindsay, R. B., Scientific Monthly, Oct. 1954.

63 Smith, Vincent E., Scienee and Philosophy, Bruce Publishing Co., Milwaukee, 1965, page 63.

64 Bohm, David, The Special Theory of Relativity, W. A. Benjamin, New York, 1965, page 172.

65 Verschuur, Gerrit, The Invisible Universe, Springer-Verlag. New York. 1974. page 138.

66 Dingle, Herbert, The Special Theory of Relativity, Third Edition, Methuen & Co., London, 1950, page 1.

67 Moller, C., The Theory of Relativity, The Clarendon Press, Oxford, 1952, page 49.

68 Feynman, Richard, The Character of Physical Law, op. cit., page 97.

69 Heisenberg, Werner, Physics and Philosophy, op. cit., page 120.

70 Asimov, Isaac, The New Intelligent Man’s Guide to Science, Basic Books, New York, 1965, page 283.

71 Walker, Marshall, op. cit., page 54.

72 Einstein and lnfeld, op. cit., page 159.

73 Ford, K. W., Scientific American, Dec. 1963.

74 Verschuur, Gerrit, Starscapes, Little Brown & Co., Boston, 1977, page 173.

75 Rees, M. J., The Srate of the Universe, edited by Geoffrey Bath, Clarendon Press, Oxford, 1980. page 39.

76 Harwit, Martin, Astrophysical Concepts, John Wiley & Sons, New York, 1973, page 9.

77 Hoyle, Fred, New Scientist, Oct. 17, 1968.

78 Lovell, Bernard, Cosmology Now, op. cit., page 7.

79 Mitton, Simon, Astronomy and Space, Vol.1, edited by Patrick Moore, Neale Watson Academic Publishers, New York, 1972.

80 Ryle, Martin, Cosmology Now, op. cit., page 42.

81 Einstein, Albert, Relarivity, op. cit., page 126.

82 Lovell, Bernard, The Individual and rhe Universe. Oxford University Press, London, 1959, page 78.

83 Hoyle, Fred, Galaxies, Nuclei, and Quasars, Harper & Row, New York, 1965, page 4.

84 Sciama, Dennis, Cosmology Now, op. cit., page 56.

85 Verschuur, Gerrit, Starscapes, op. cit., page 177.

86 Ibid., page 18l.

87 Jastrow and Thompson, Astronomy: Fundamentals and Frontiers, John Wiley & Sons, New York, 1972, page 226.

88 Mitton, Simon, 1973 Yearbook ot Astsooomy.

89 Ryle, Martin, Cosmology Now, op. cit., page 41.

90 Bohuski and Weedman, Astrophysical Journal, Aug. 1, 1979.

91 Bath, G. T., The Srare of rhe Universe. op. cit., page 12.

92 Verschuur, Gerrit, The Invisible Universe, op. cit., page 139.

93 Pasachoff, Jay, Asrronomy Now, W. B. Saunders Co., Philadelphia, 1978, page 385.

94 Rees, M. J., Cosmology Now, op. cit., page 129.

95 Lovell, Bernard, Ibid, page 8.

96 See discussion in Verschuur, Starscapes op. cit., page 190,

97 Jastrow and Thompson, op. cit., page 207.

98 Shklovskii, I.S., Srars: Their Birth, Life and Death, W. H. Freeman & Co., San Francisco, 1978, page 66.

99 Mitton, Simon, Exploring the Galaxies, Charles Scribner’s Sons, New York, 1976, page 89.

100 McCrea, W. H., Cosmology Now, op. cit., page 94.

101 John, Laurie H., Ibid, page 85.

102 Rees, M. J., The State of rhe Universe, op. cit., page 35.

103 Hirshfeld, Alan, Sky and Telescope, April 1980.

104 Harwit, Martin, op. cit., page 43.

105 Struve, Otto, Sky and Telescope, July 1955.

106 Marshak, Robert E., The Scientific American Reader, Simon & Schuster, New York, 1953, page 177.

107 Opik, E. J., Smithsonian Treasury of Science, Vol.1edited by Webster P. True, Simon & Schuster, New York, 1960, page 38.

108 Bok, Bart J., The Asnonomer's Universe, Cambridge University Press, 1958, page 91.

109 King, Ivan R., The Universe Unfolding. W. H. Freeman & Co., San Francisco, 1976, page 464.

110 Struve, Otto, Sky and Telescope, June 1960.

111 Hogg, Helen S., Encyclopedia Brinanica, 15th Edition, Vol. 17, page 605.

112 Van den Bergh, Sidney, Annual Review of Astronomy and Astrophysics, 1975.

113 Lohmann, W. Zitschrift für Astrophysik, Aug. 1953.

114 Iben, Icko, Jr., Scientific American, July 1970.

115 Bok and Bok, The Milky Way, 4th Edition, Harvard University Press, 1974, page I17.

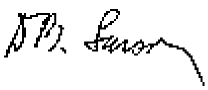
116 Ibid., page 249.

117 Struve, Otto, Sky and Telescope, Apr. 1960.

118 Hogg, Helen S., op. cit., page 608.

Silk, Joseph, The Big Bang, W. H. Freeman & Co., San Francisco, 1980, page 248.

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*,

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

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.	economic problem. The Road to Permanent Prosperity A theoretical explanation of the business cycle and the means to overcome it.