Science Without Apologies

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

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

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

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

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

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

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

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

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

A significant consequence of this lack of a general theory is an inability to arrive at an understanding of the most fundamental scientific entities and phenomena. In fact, a complete understanding of these fundamental entities would be g general theory. Gravitation is an outstanding example. According to R. H. Dicke, "it may well be the most fundamental and least understood of the interactions." Dean E. Wooldridge gives us this assessment:

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

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

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

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

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

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

> The fundamental nature of astrophysical discoveries being made—or remaining to be made—leaves little room for doubt but that a large part of current theory will have to be drastically revised over the next decades. Much of what is known today must be regarded

as tentative and all parts of the field have to be viewed with healthy skepticism.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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