Twienty Years' Progress

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

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

I have always been very much interested in the theoretical aspect of scientific research, and quite early in life I developed a habit of spending much of my spare time on theoretical investigations of one kind or another. Eventually I concluded that these efforts would be more likely to be productive if I directed most of them toward some specific goal, and I decided to undertake the task of devising a method whereby the magnitudes of certain physical properties could be calculated from the chemical composition. Many investigators had tackled this problem previously, but the most that had ever been accomplished was to devise some mathematical expressions whereby the effect of temperature and press are on these properties can be evaluated if certain arbitrary "constants" are assigned to each of the various substances. The goal of a purely theoretical derivation, one that requires no arbitrary assignment of numerical constants, has evaded all of these efforts.

It may have been somewhat presumptuous on my part to select such an objective, but, after all, if anyone wants to try to accomplish something new, he must aim at something that others have not done. Furthermore, I did have one significant advantage over my predecessors, in that I was not a professional physicist or chemist. Most people would probably consider this a serious disadvantage, if not a definite disqualification. But those who have studied the subject in depth are agreed that revolutionary new discoveries in science seldom come from the professionals in the particular fields involved. They are almost always the work of individuals who might be considered amateurs, although they are more accurately described by Dr. James B. Conant as "uncommitted investigators." The uncommitted investigator, says Dr. Conant, is one who does the investigation entirely on his own initiative, without any direction by or responsibility to anyone else, and free from any requirement that the work must produce results.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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