Around Unexpected Corners

Autobiographical info on the beginning of the Reciprocal System, 1968

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About twenty years ago Dr. James B. Conant, at that time president of Harvard University, gave a talk to a group of chemists and chemical executives in which he expressed serious concern over the effect on scientific progress that was likely to result from the virtual disappearance of what he called the “uncommitted investigators,” a term which he applied to those individuals who carry on scientific research work on their own initiative, without support from or direction by the established research agencies. As Dr. Conant put it, these individuals “could investigate what they pleased when they pleased, or break off research at any point. They were as free as the wind because they had no program except the ever-changing one in their own minds.”

The reason for his concern, Dr. Conant explained, was that although the great majority of new discoveries in the scientific field are made by professional scientists working under the auspices of universities or research laboratories, the really revolutionary ideas, those that actually change the course of scientific progress, have come mainly from the free-wheeling activities of these *uncommitted investigators*, and if such individuals are no longer active, there is no assurance that these much-needed ideas will continue to materialize. In Dr. Conant’s own words: “The revolutionary advances in theoretical science were made very largely by amateurs… 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. If you want advances in the basic theories of chemistry and physics 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. By definition the unexpected corner *cannot* be turned by any operation that is planned.”

I have quoted at considerable length from the words of this very distinguished member of your chemical profession because what I am going to do this evening is to take you behind the scenes and give you a sort of a play by play account of a research project carried out by the kind of an individual that Dr. Conant was talking about, a member of that strange and nearly extinct species, the uncommitted investigator.

This project that I am going to discuss ultimately produced a new general physical theory. It is quite likely that many of you will find it difficult to understand how anyone would select such an objective; how anyone in his right mind would deliberately undertake the colossal task of trying to fit all of the immense amount of scientific information that is now available into a totally new pattern. So I want to explain to you that my original objective was a much more modest one, but we uncommitted investigators rarely hit where we aim. In this case, an effort originally aimed at that relatively modest objective got out of hand, so to speak, and kept on growing and turning unexpected corners until it finally produced a result that was never anticipated.

As chemists, you may be interested to know that the subjects I originally selected for investigation were the physical and chemical properties of matter. These properties, as you know, are essentially mathematical. We sometimes express them in non-mathematical terms. For instance, under ordinary conditions, mercury is liquid and lead is solid, and we somewhat loosely refer to these facts as properties, but actually all that we have here is a difference in the melting point. The same is true of properties in general; that is, in the final analysis they reduce to nothing more than a set of numbers. But we also start with nothing but a set of numbers. So far as we know, the only basic difference between mercury and lead is that mercury is number 80 in the atomic series and lead is number 82. It logically follows, therefore, that if we can find the right method of approach we should be able to establish a relation between these two sets of numbers; that is, we should be able to construct a set of mathematical expressions which we can enter with the number 80 and come out with the melting point and other properties of mercury, and we can enter with the number 82 and come out with the properties of lead. What I undertook to do was to see if I could find the key that would enable formulating this set of relationships.

I realized, of course, that some totally new line of attack would have to be devised if I were to have any chance of accomplishing anything of value in a field that had been combed over so often and so thoroughly as this one, but it was my opinion that the possibilities in this respect were by no means exhausted. In fact it seemed to me that there was one whole category of possibilities that had scarcely been touched: those possibilities that are generally regarded as being too far-fetched to justify spending any time examining them. In my home I am frequently approached by a member of the family reporting the loss of some article, along with the assertion that a careful search has been made "everywhere that it could possibly be." My response in these cases is that if this is true we must then begin to look in the places where it *cannot* possibly be, and this is where we almost invariably find the missing article. What I proposed to do was to apply this same policy to the problem at hand; to concentrate my attention on the exploration of those ideas which have heretofore been summarily dismissed as not worthy of consideration. As I saw the situation, the desirability of this kind of an attack was particularly indicated by the strong resistance which the problem had offered to previous investigators. Experience has shown that long-continued inability to solve a basic problem nearly always indicates that some element entering into the problem is not what it appears to be. Some one of the actors is wearing a mask, and we don't know which one it is. Somewhere along the line that which is true is being made to appear false because that which is false is accepted as truth.

On the strength of these considerations, I spent several years examining the consequences of ideas which at first glance seemed absurd. After long and careful consideration, that is just exactly what most of them turned out to be. They *were* absurd. I have no intention of ever revealing just what ideas I investigated, because, while I have a rather thick skin, it is not totally impenetrable, and some of the aspersions that would be cast on the intelligence, if not on the sanity, of anyone who would waste his time investigating such subjects would undoubtedly get through my armor plate. I am quite certain that a common reaction to item X, let us say, would go something like this, "How could anyone be so stupid as to think that there might be anything of value in that idea?" What this typical critic would fail to see is that my whole project was based on the premise that no one can tell in advance what is absurd and what is not absurd. *Before* the study was made, item Y and item Z looked every bit as absurd as item X, but Y and Z turned out to be diamonds in the rough. There were a number of such diamonds among the many worthless stones, and eventually some promising new lines of inquiry were opened up.

Work along these lines ultimately produced a number of very interesting results of a mathematical nature. According to the most influential school of modern scientific thought, this is where I should have stopped, because, these eminent scientists assert, when we know that much—that is, when we can express our knowledge mathematically—we know all there is to know about a subject. The application of this currently fashionable viewpoint to the gravitational situation is expressed by this statement that I have taken from a current textbook: "Why does a stone that is released from the hand fall to the ground? The answer is that there is a force of attraction between earth and stone for which Newton's law of gravitation holds. It does not make sense to ask further how this force of attraction comes about." I cannot subscribe to this doctrine. In fact, my suspicious nature will not even let me believe that the authors themselves really put any particular stock in it. I have noticed that this idea became popular among the physicists only *after* those physicists had tried long and hard to find the explanations that they now say are superfluous. As I mentioned in one of my publications, their present attitude reminds me of a bit of Chinese philosophy which asserts that if one cannot get what he wants, he can arrive at exactly the same end by persuading himself to want what he can get. But I am afraid that I am not a very faithful disciple of Confucius. As I see it, any purely mathematical knowledge of a physical situation is inherently incomplete and therefore not fully satisfactory. Even at the risk of being considered stubborn and unreasonable, I want some names that can be attached to the numbers. Contrary to the statement that I have just read, I believe that it does make sense to ask how and why.

So whenever I established a mathematical relation, I immediately began looking for an explanation that would account for it. One of the most intriguing of these expressions was a relation between the atomic number or numbers and the inter-atomic distance in the solid state, and this also turned out to be one of the most frustrating as well, because for a number of years I spent a very large part of my available time trying to find an explanation of this peculiar and puzzling expression. Up to this time I had been working entirely along orthodox lines. I was examining some very strange ideas, to be sure, but that examination was being carried out within the framework of accepted scientific thought. Here is where I left the reservation. After this long period of frustration in trying to find an orthodox explanation of the mathematical relation that I was studying, it finally occurred to me that a very simple explanation would be forthcoming if I made a highly unorthodox assumption about the relation of space to time: the assumption that there is a general reciprocal relation between these two entities.

My immediate reaction to this thought was the normal one—the same reaction that almost everyone has when he first encounters the idea—a sort of an intuitive feeling that the concept of the reciprocal of space is utterly ridiculous; that we might equally well speak of the reciprocal of a cocker spaniel or the reciprocal of a load of hay. But I could not permit myself to accept this initial emotional judgment. I had to say to myself, "See here, this is just exactly what you have set out to do; to examine those thoughts that seem like nonsense, and to see if you can't find something of value in them".

So I began to take a critical look at the reciprocal concept, and as soon as I did so, it was immediately apparent that this idea was *not* so absurd, after all, since there definitely *is* a reciprocal relation between space and time in the *only* physical phenomenon in which we can recognize a direct association between the two: the phenomenon of *motion*. In motion more space is the equivalent of less time and vice versa. It makes no difference whether we travel twice as far in the same time or whether we travel the same distance in half the time. The effect on the speed, the scalar measure of the motion, is exactly the same in both cases.

Then, too, it was also evident that this reciprocal assumption was opening the doors to some new and logical answers for long-standing problems in physical science. One of these, a very important one, is the problem of gravitation. Here is one of the foundation stones of physical science. In the words of Paul R. Heyl, one of the leading investigators of the subject, "The more we study gravitation, the more there grows upon us the feeling that there is something peculiarly fundamental about this phenomenon to a degree that is unequaled among other natural phenomena." Actually we do not know very much about it. Aside from some information of a mathematical nature, such as the inverse square relation, the relation of the force to the masses involved and the value of the gravitational constant, about all that we know from observation is that gravitation acts instantaneously, without an intervening medium, and in such a manner that its effects cannot be screened off or modified in any way. The point that impressed me most forcibly at the very beginning of my application of the reciprocal assumption to the gravitational problem was that this assumption led directly to a theoretical situation in which gravitation acts instantaneously, without an intervening medium, and in such a manner that its effects cannot be screened off or modified in any way.

Perhaps this may not strike you as anything particularly significant. Your reaction may be, “So what? Doesn’t *any* theory have to agree with the observed facts in order to be considered valid?” And I would have to concede that as a general proposition this is true. But the significant point in this case is that *no* previous theory has agreed with the observed facts, and what is even more significant, present-day theorists are so convinced of the impossibility of *ever* formulating a theory that will agree with these facts that they have adopted the unprecedented policy of constructing a set of fictitious facts with which they *are* able to show agreement, and substituting these fictitious facts for the facts of observation.

Even though there is not the slightest evidence that gravitation is propagated at a finite velocity, present-day theorists have made this the cornerstone of their gravitational theories. It is not even *claimed* that this assumption is supported by any facts. Max Von Laue, for instance, makes this very frank admission, “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.” Then since such a propagation requires a medium, the theorists have had to assume the existence of a medium, even though here, again, there is not the least bit of evidence to support such an assumption.

It is commonly stated in the textbooks that Einstein’s theories eliminated the need for a medium and consigned the “ether” of the nineteenth century to oblivion. But this is a misrepresentation of the facts. Einstein’s accomplishment in this area was merely a bit of scientific legerdemain. R. H. Dicke, one of our present-day gravitational experts, calls it a “semantic trick.” Before Einstein, science had two concepts in this area, one which was called “space” and another that was called the “ether”. What Einstein did was to eliminate the *concept* “space” and the *name* “ether,” so that what current physical theory now has is the concept formerly known as the ether, but it is now called “space”. Einstein himself cannot be charged with misrepresentation, as he freely admits that his space is actually an ether. “According to the general theory of relativity,” he says, “space is endowed with physical qualities; in this sense, therefore, there exists an ether.” Just how it is possible for an intangible entity such as space to have these physical qualities is a subject on which he is very vague. In his words, “Our only way out seems to be to take it for granted that space has the physical property of transmitting electromagnetic waves, and not to bother too much about the meaning of this statement.”

The most striking result of the application of the reciprocal assumption to the gravitational phenomenon is that it produces a totally new explanation of a logical and rational character in an area where scientists have long been convinced that they have examined all possibilities and that no genuinely new explanation is possible. It is asserted over and over again in the scientific literature that there are only two options; either gravitation involves action at a distance, a concept that is generally rejected by scientists, or else it must be propagated at a finite velocity. We are told that any other alternative is logically impossible. But notwithstanding this dictum, another rational alternative *does* appear as soon as we start to examine the consequences of the reciprocal assumption.

This is no isolated case. Time and time again during the development of the new system of theory, completely new answers have been obtained in areas where present-day science claims to have examined “all conceivable alternatives.” “There is no other way,” Einstein tells us, in speaking of his assumption as to the contraction of space. But there is another way, and just as soon as this other way emerged from the investigation that I am now discussing, all contentions that it did not exist were immediately and totally demolished. This is not a matter of opinion or judgment; just as soon as another alternative to *anything* is produced, all assertions that there is no such alternative fall by their own weight. It is clear from the many results of this kind that I have obtained that the human race has not yet reached the point where it is *ever* safe to assume that all possible alternatives have been examined. We may be wise, as we are claiming when we apply the name *Homo sapiens* to our species, but we are not yet omniscient. Regardless of any other merits that it may have, the investigation on which I have been engaged has made a very definite contribution to science by puncturing the claims of those who attribute finality to the current scientific opinions and theories.

This has a particular significance for those of you who are just beginning your life's work, because it means that, regardless of all contentions to the contrary, no doors are closed to you. You do not have to listen to those who say that their ill-contrived and unproductive ideas must be accepted because there is no other way. You do not have to be content with theories that are "conceptually imperfect," "riddled with inconsistencies," or full of "intolerable paradoxes," all of which are descriptions that have been applied to some of the most cherished products of modern science by prominent members of the scientific profession. You do not have to accept the statements of those who presumptuously assert that they have already examined all conceivable alternatives. Not only in science, but in all fields of human activity, you are at liberty to reach for the stars, and to reject the counsel of those who insist that you must be limited by the failures of your predecessors. There are some other limits, it is true. You cannot get something for nothing; you cannot have your cake and eat it too; and so on; but wherever there are genuine problems there are also answers, and those answers can be found if you will look for them without fixed presuppositions and prejudices.

At the stage of my investigation when I had completed my initial consideration of the most immediate consequences of the reciprocal assumption, some of these long-sought answers were beginning to appear over the horizon, and it was therefore clear that I had no option but to continue with my investigation, even though the task ahead was now vastly greater than anything that I had in mind initially. This is a good example of what I was talking about earlier when I said that the investigation got out of hand, so to speak. You will note that at this point the sheer force of circumstances generated by the project itself simply forced me into a path that I previously had no intention of taking, and gave me a momentum toward a goal that had no place at all in my original plans.

The first problem with which I was confronted at the start of this new phase of my project was the necessity of making a decision as to the course of procedure to be followed. After considering various possibilities, I concluded that it would be advisable to see how far I could go in constructing a purely deductive system, starting with a minimum number of assumptions and developing the consequences of those assumptions step by step without introducing anything from outside the system. The construction of a theory of this kind comprehensive enough to cover the physical universe as a whole has always been the dream of science, and since the philosophy that I have just been expounding to you tells us that we should aim high, I decided that I should at least make the attempt.

Just what constitutes a minimum number of assumptions is not self-evident, but a review of those phenomena to which the reciprocal assumption appeared to be the most directly applicable, particularly electromagnetic radiation and the recession of the galaxies, indicated that the only physical assumptions, in addition to the reciprocal relation, that would be required to define these phenomena were that space and time are three-dimensional and that they exist only in discrete units. On the mathematical side, extrapolation of experience led to the assumptions that space and time conform to the relations of ordinary commutative mathematics, that their magnitudes are absolute, and that their geometry is Euclidean.

What I had in mind in starting the development with nothing but motion and its two aspects, space and time, and with only these six assumptions as to the properties of these entities, was that I would go as far as I could on this basis and then, when something else was needed in order to continue the development, I would introduce additional assumptions accordingly, keeping the number of these assumptions always at the bare minimum. It seemed rather obvious; for one thing, that I would not get very far before it would be necessary to assume the existence of matter. But much to my surprise, when I examined the different kinds of motion that could exist on the basis of the original six assumptions, I found that one of these, simple rotational motion, would necessarily exist in the form of individual units, of such a nature that we can readily identify them as atoms; that these atoms would behave as if they were exerting mutual forces of attraction upon each other, a phenomenon that we can identify as gravitation; that the addition of successive units of motion to the different dimensions of the atomic rotation would take place in a definite sequence, resulting in the formation of a regular series of combinations that we can identify as the chemical elements; and so on. Thus both the existence and the characteristics of matter were consequences of the six assumptions already made, and it was not necessary to assume the existence of matter independently.

Since I now had both matter and motion to build with, the question naturally arose: Is anything else of a basic nature actually necessary? Twenty years of additional work answered this question in the negative. The only additional assumption that I found it necessary to make is the assumption that no more assumptions are required; that is, the assumption that space-time, or motion, whichever you prefer to call it, is the *sole* constituent of the physical universe. For convenience, I have combined this new assumption and the original six into two postulates, one as to the physical nature of space and time, and the other as to their mathematical behavior. The new physical theory that I am discussing this evening is a purely theoretical structure derived from these two postulates, and *only* these two postulates, without introducing *anything* from observation or from any other outside source. The mere existence of space and time with the postulated properties has certain primary consequences. Interaction of these primary consequences with each other and with the postulates then results in a large number and variety of secondary consequences which, in turn, give rise to still further consequences, and so on until a whole theoretical universe has been defined.

For the next two or three minutes I am going to be saying some things that might give you the impression that I have interrupted my talk for a commercial. But my only excuse for taking up your time at all is that I believe it would be distinctly to your advantage to become familiar with these new developments, and I have now arrived at the point where I should give you some specific reasons why this is true.

The fact that this new theoretical system derives conclusions applicable to all sub-divisions of physical science from the same premises means that we now have, for the first time, something that can legitimately be called a theory of the physical universe. Few previous theories are applicable to more than one of these subdivisions, and none is applicable to many of them. No previous theory, for instance, can produce a logical explanation of the recession of the galaxies, *and* of gravitation, *and* of the basic structure of matter, *and* of the nature of electromagnetic radiation. But all of these are merely the *immediate* and *direct* consequences of the basic postulates of the new system, just the beginning of the vast amount of information that can be derived by a more complete development of these consequences.

This comprehensive nature of the new theoretical system is the first of its distinctive characteristics that

I want to emphasize. But the same thing that makes it a *complete* theory, the fact that it derives conclusions applicable to all sub-divisions of physical science from the same premises, also makes it possible to demonstrate that it is a *correct* theory, and that the theoretical universe derived from it is a true and accurate representation of the actual physical universe. The best way of explaining how such a proof of the validity of the system can be accomplished is to compare the construction of a theory to the preparation of a map.

Both maps and theories are often wrong, and they must be checked for accuracy before we can have full confidence in them. But the process by which the map or theory was produced has an important bearing on the nature of the tests that we apply and on the kind of conclusions that we are able to draw from the tests. In the case of a product of the traditional map making or theory construction processes, there is no option but to check each feature of the map or theory individually because, with relatively few exceptions, verification of any one feature does not guarantee the accuracy of any other feature. Verification of the position shown for a river in one part of the map does not assure us that the position shown for a mountain in some other part of the map is correct.

On the other hand, if a map or theory is prepared in one operation by a single process, as is true when the map is the result of aerial photography, and as is also true where all of the conclusions of a theory are derived from a single set of premises, the nature of the test is quite different. It is still necessary to compare some of the features of the map or theory with information that has been derived from other sources, but in this case the verification of the individual features is merely incidental. The important point is that each such check is a test of the accuracy of the process. If even one feature of the map or theory is found to be in conflict with positively established facts derived from other sources, then the process is inaccurate and the map or theory as a whole is unreliable. But if no such discrepancy is found in the initial examination, then every additional check that is made without finding any discrepancy reduces the mathematical probability that any discrepancy exists anywhere in the map or theory. By making a sufficiently large number and variety of such checks, the probability of any error can be reduced to the point where it is negligible.

Of course, I have not yet examined the application of my new theoretical system to more than a relatively small portion of the total world of physical phenomena, for reasons which should be obvious. But, as I have just brought out, it is not necessary to check more than a representative sample of the features of an aerial photograph, or a theory of the analogous type, to be certain of its accuracy, and by this time I have examined the application of the theory to the fundamentals of all of the major branches of physical science, and I have made enough checks of the kind that I have been talking about to reduce the possibility of any basic error in the system practically to the vanishing point. Of course, the possibility that there may be some flaw in one or more of the long chains of reasoning by which conclusions regarding some of the finer details were reached cannot be excluded, but aside from this, I am now able to assert that the new theoretical system is an accurate representation of the physical universe.

If I had unlimited time, this is the point at which I would begin developing the specific consequences of the postulates and thereby defining the theoretical universe in detail. But I cannot construct a universe for you in a few minutes. As I understand it, such a task has never been accomplished in less than six days. So the best that I can do is to give you an illustration of the kind of new and logical answers to long-standing problems that emerge from this development. Since I have already discussed the gravitational problem at considerable length, this will be an appropriate example.

Inasmuch as the reciprocal of unity is unity, it follows from the reciprocal relation between space and time that one single unit of space is equivalent to one single unit of time. Consequently, when an additional unit of time has elapsed and some location A has progressed to A+1 in time, it has also progressed to A+1 in space; that is, there is a continuous progression of space similar to the progression of time that *we* ordinarily visualize. This means that the space-time system is not a static system of the kind that we can represent by fixed coordinates; it is a moving system analogous to an expanding balloon. If there are spots painted on the surface of such a balloon, the distance between them is continually increasing, but this does not indicate any actual motion of the spots. They are fixed and they *cannot* move. The increase in separation is a property of the *system* in which the spots are located, not of the spots themselves. If there are any objects on the surface of the balloon that *do* move, the true measure of their motion is not the observed increase in separation, but the amount by which this observed increase is more or less than that which would exist if these object remained fixed to the surface in the same manner as the spots.

Whatever problem there may be in grasping the true situation here is simply a matter of getting accustomed to the idea of a moving system of reference. We ordinarily think of such things as location and motion in terms of a three-dimensional reference system that is stationary in space. But it is obvious that such a reference system is not applicable to an expanding balloon. A spot on this balloon that in fact *cannot* move and must remain permanently in the same location *does* move with respect to a fixed coordinate system. The use of such a reference system therefore gives us a completely distorted view of the situation. It attributes motion to objects that cannot and do not move, and it gives us a totally unrealistic picture of the motion of any objects that do move. In order to get the true picture of what is actually happening on the surface of the balloon we must utilize a moving reference system.

The same is true of the physical situation. We live in a space-time system which is continually expanding because of the equivalence of the unit of space and the unit of time. The distant galaxies are analogous to the spots on the balloon, and the motion that carries them outward away from us and away from each other is not actually a motion of the galaxies at all; it is a property of the system: the space-time system in which these galaxies are located. If any particular galaxy does have a motion of its own, the true measure of that motion is not the motion that we observe, but the amount by which the observed motion differs from that which would exist by reason of the space-time progression alone. Here again, as in the case of the expanding balloon, we can get the true picture of what is happening only by the use of a moving reference system.

Now for a still closer analogy, let us replace the expanding balloon by an expanding transparent solid, and let us assume that there are visible objects in the interior of this solid analogous to the spots on the surface of the balloon. All that has been said about the expanding balloon is now equally applicable to the expanding solid. Then let us further assume that we take a moving picture of the expanding solid under lighting conditions such that we see only the objects in the interior and not the transparent solid itself. What this picture will show is a group of objects that are continually moving outward away from each other. Here we have a model of the galactic recession.

Next let us run this film backwards. What we will now see is a group of objects that are continually moving inward toward each other. If we had no knowledge of how this situation originated, we might very well conclude that these objects *were* exerting forces of attraction upon each other, and with a little ingenuity we could devise a mathematical expression that would enable us to calculate the magnitude of the force between any two of the objects, even though such forces do not actually exist. This analogy should give you a good understanding of the explanation of gravitation that is produced by the new system of theory, and it should also enable you to understand why previous gravitational theories have gone wrong. All previous theories have assumed that gravitation is a force, or at least some kind of an effect, that is exerted by one mass upon another, and the stumbling-block for these theories has been the fact that they could not account for the peculiar characteristics of the gravitational force, characteristics which are totally unlike those of any other force with which we come in contact. According to the new theory each atom of matter has an inherent motion in the inward space-time direction, and the peculiar characteristics of the gravitational force are all due to the fact that there actually is no force at all. As in our model, each unit is pursuing its own independent course, but that course takes it inward toward all other such units.

A question that is frequently asked is: "What happens to existing physical theory if your conclusions are correct; will a wholesale reconstruction of present theory be necessary?" The answer to this question is definitely, no. It is true that the new system does require some drastic changes in thinking in the far-out regions, the realms of the very small, the very large, and the very fast, but it should be realized that the present state of theory in these areas is little short of chaotic. Indeed, along the outer boundary lines present theory is essentially nothing more than speculation.

I recently purchased a book that purports to summarize all that is now known about the subject that it covers, one of the subdivisions of science in which I am particularly interested at the moment. The preface to this book contains the following very significant admission: "it will be seen from the discussion in the later chapters that there are so many conflicting ideas concerning theory and interpretation of the observations that at least 95 percent of them must indeed be wrong. But at present no one knows which 95 percent." This is an extreme case, to be sure. There are not many scientific areas in which as much as 95 percent of current thought is incorrect. But there are a great many areas in which there is a very substantial percentage of error, a much greater percentage than is generally admitted. The existing situation, with particular reference to physics, is summed up in this statement taken from a recent issue of the magazine *Science News,* "The conditions are these: a large number of well-ordered facts, with no present way of explaining them, and a large body of frustrated scientists."

My finding is that this frustration is a direct result of the fact that modern theorists have abandoned the traditional methods and goals of science. Up to about a century ago, the task of science was almost universally regarded as a matter of *discovery.* As expressed by R. B. Lindsay in a recent article in one of the journals, "Application of the term 'discovery' implies that there is an external world 'out there', wholly independent of the observer and with built-in regularities and laws waiting to be uncovered and revealed. They have always been there and presumably always will be; our task is by diligent search to find out what they are." This was the viewpoint of Galileo, of Newton, and the other great pioneers of science.

The modern scientific establishment has repudiated this traditional viewpoint, and their present attitude is described by Lindsay in these words: "We are essentially viewing the purpose of physics as a scientific discipline as *invention* rather than discovery… The term invention implies that the physicist uses not only his observations but his imaginative powers to construct points of view that identify with experience." Einstein was very emphatic on this score, and insisted over and over again that "we can only grasp physical reality by speculative means." McVittie makes the same point in these words: "The Laws of Nature… are to be regarded as free creations of the human mind." The inevitable result of giving free rein to the imagination in this manner has been that physical theory has lost touch with reality and has embarked on a course of pure speculation. Just in case you might feel that this picture that I am giving you is overdrawn, let me say that Werner Heisenberg, one of the principal architects of the modern speculative theory, is on record to exactly the same effect. He admits that modern science has "lost… the whole representation of reality which has been the basis of the exact natural sciences up to the era of today's atomic physics."

When our primitive ancestors were confronted with something which they could not understand, their answer was to invent what we may call a demon, a supernatural being or power drawn from their imagination and specifically adapted to the purpose at hand. When the present-day theorist is similarly confronted with something which *he* cannot understand, he does exactly the same thing.

He, too, invents a demon, a hypothetical force or phenomenon, which is designed specifically for this purpose, which has no other function, and whose existence cannot be verified by any independent evidence. There is no essential difference between the "rain god" that brings a much-needed shower for the benefit of the crops of the primitive tiller of the soil and the "nuclear force" that holds the hypothetical nucleus of the atom together for the benefit of the modern theorists. The explanations sound different, of course, because each cultural and professional group has its own jargon, but the essential character of the explanations would remain unchanged if the primitive farmer propitiated the "rain force" and the physicist invoked the aid of the "god of the nucleus." A demon is a demon, regardless of the particular linguistic clothes that he may happen to wear.

It is the wholesale use of these demons, and the consequent retreat from reality, that is responsible for the unsatisfactory state in which so-called "modern science" now finds itself, and it should be no occasion for surprise when a new theory that does not utilize demons calls for some drastic changes in the most demon-infested areas. But it should be remembered that, in spite of the great amount of publicity that they receive, these highly speculative modern developments actually constitute only a relatively small part of physical theory in general. Even the physics textbooks rarely devote more than ten percent of their contents to material of this nature, and the effect on other branches of science is very much less. The remainder of physical theory, perhaps as much as 95 percent of the total, has been constructed by the sound and reliable methods of traditional science rather than by "free inventions of the human mind," and my new theoretical system is generally in accord with this sound portion of existing theory.

As I have stated in my books, almost all of the theoretical relations applicable to our immediate environment that are firmly enough established to enable using them on a practical basis—such relations as Newton's laws of motion, the gas laws, the laws of thermodynamics, the kinetic theory, and so on—can be derived from the postulates of the new system in essentially the same form in which they are now known. Even the changes which the new theoretical system does make in these more familiar areas are often more a matter of altering the terminology than of any substantive modifications.

But there are many gaps in existing theory, and these gaps are so prominent in your own branch of science that chemistry is often characterized as primarily an empirical science. The leaders of your profession have long been hoping to remedy this situation by developing an adequate chemical theory. At one time it was thought that the application of quantum mechanics to chemistry might be the answer, but the results of this effort have been disappointing. In fact, Professor Henry Bent of the University of Minnesota makes this flat statement in an article in the magazine *Science*; "This (30 years of) labor has produced not one firm prediction about even the simplest test-tube experiment."

You and your profession are thus in a very favorable position to get the maximum amount of benefit out of the new development that I have been describing to you, a development that will ultimately give you that comprehensive chemical theory that has so long been lacking. It is on this basis that I commend it to your thoughtful consideration.

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