antagonistic relation to one another. The two aspects of the unitary principle are but different aspects of one overriding field tendency and are often mutually cooperative. Evolution, development, and learning in modern unitary thought, moreover, takes place by two similar structures combining with one another. This combination serves to differentiate a larger structure of which both are a part. An application of modern unitary theory to the current scene implies that the healthy tendencies of the two leading world economic systems would be best served by the combination (via cooperative activity) of similar aspects of both of these economic systems to form a larger and more efficient economic system. This implies an economic system operated by a staff of economic specialists for the benefit of the peoples of both nations. The antagonism between these two economic systems, the result of the application of the distorted doctrines, is artificial and promoted by men who place their own privileged power interests above the healthy growth of their nation's 55
economic system.

An alternative viewpoint in regard to these dualistic unitary principle-process doctrines might be to consider them not as distortions of the process concept but as the unsophisticated expressions of a more modern doctrine much as Pythagoras's doctrine of natural law was an unsophisticated expression of the concept of mathematical law. It is quite possible, moreover, that both the dualistic and the modern field-process doctrines have arisen from an archetype explanation of all process concepts: the mistaken and then reified notions once referring to the sexual process and the dichotomy of the two sexes. It may also be that the doctrine of mechanistic-materialism, and Aristotle's doctrine of orthogenesis, as well as many other doctrines spring form this same primitive archetype explanatory source. To be traced to this source may not be very flattering to modern systems including the modern version of unitary theory.[3] Respectability or unrespectability of an idea is not conferred by the dignity of the source of origin of a concept but the determining factor is whether or not the concept

[[3] In this regard is meant the subjective reaction of the puritanical proponents of modern pure science. It is high time that this self-defeating puritanical spirit was removed from pure science once and for all, especially if the social sciences expect to capture the allegiance and imagination oft he society of the nuclear age. Much evidence from clinical psychology points to the possibility that the puritanical personality may really be a human in a state of compulsive-obsession neurosis. (The technical term for the defensive mechanism whose exaggeration manifests itself in the "compulsive-obsessional" syndrome is called "reaction-formation." Thus this type of individual says and does the opposite of what he really feels.) This rare state of neurosis can be traced to the reaction of the now-classical cultures of Greece, Rome, India, and other near-Eastern peoples such as the Hebrews, to the monopolizing of women by a few men during the time of the great barbaric empires of Babylonia and Assyria. The reaction to this situation occurred around 1000 B.C. and led to the formation of the puritanical morals and is thus found in the cultures of all of these peoples. These puritanical norms of behavior were not, however, directed against the human need for adventure and novelty in the realm of romance and sex experience. They were the result of the subjective "reaction-formation" on the part of the vast majority of frustrated men to an unfair situation. These puritanical norms were later petrified as social norms of Western man because the emerging Western barbarian literally accepted them along with the cultures he absorbed, but the context which gave true meaning to puritanical norms was thereby lost. Thus, a neurotic defensive technique that originally served to allay the frustrated majority's anxiety became espoused as one of the highest ethics of Western man for the next two thousand years. This social norm of puritanism as regards man's need for romantic adventure is responsible for the characterization of the whole history of Western man, including his science, by a compulsive-obsessional syndrome whose ramification has reached far beyond the romantic-sexual realm. The vaunted "image of man" that has been handed down to us is a neurotic man or, at best, a conventional-conforming, adolescent type of man. Western man has progressed and grown because he has rejected (in practice)this image of man. The time has come to make the romantic man respectable to all spheres of human life and to dispatch the puritan to the realm of abnormality where he seems to belong.]

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has substance, that is, can be verified by scientific method. 56

This brings us to the rise of scientific method in Western civilization. Almost 1500 years after the death of Aristotle, we find the re-introduction of classical Greek and Roman thought into Western culture. This Renaissance of Greek philosophical thought, in the last years of the twelfth century, was to lead to two lines of thought, with us today, and the other of which is the main stream of scientific thought to the present day.

The revival of particularly the Aristotelean and the Platonic systems of thought led the scholars of the Renaissance to assert that the main business of scholarship was to search for eternal principles of truth, goodness, and beauty with the utilization of deductive reasoning as the main logical process and the works of the Greek and Roman philosophers as the source of the ultimate authority. This line of thinking dominated Western thought during the thirteenth and fourteenth centuries but during this time a revolt set in, in the form of the works of such men as William of Occam and Roger Bacon.

This new revolutionary spirit held that the subject matter of scholarship was the natural sciences (meaning the physical, and later, the biological sciences) and that the main business of scholarship was to understand these fields of knowledge, not by appealing to argument or to the authority of the ancients, but by appealing to experience and to experiment and by utilizing a new mode of logical process which we now call inductive reasoning. This delimitation of the subject matter of science lasted until 1945; beauty was left to the fine and liberal arts and the pursuit of goodness or the determination of healthy human social and cultural values was left to theology, history, literature, and philosophy. After World War II, the subject matter of science was expanded to re-include these subjects for it came to be widely realized that the other disciplines had failed in the field of human values and that human values, social and cultural, must be the primary objective and concern of the social and cultural sciences. So it is today.

The first line of thought, the seeking for eternal principles of truth, goodness, and beauty, was gradually disengaged from the main stream of evolving rational thought and has come down to us as the subject matter of the humanities. The search for eternal principles of truth, however, left an important legacy to the new science. This legacy was to dominate pure
science to this date and has come to be called the “faith of the scientist.” 57
This “faith of the scientist,” expressed in its simplest form, refers to the fundamental belief of the pure scientist that, despite the complexity of forms and structures in nature, there exists an underlying simplicity of structure and, despite the diversity of laws and principles in the various branches of science, there exists an underlying unity of understanding—a single unitary law or principle upon which the unitary structure operates.

The quotation at the beginning of this section by Albert Einstein is one of several statements of this “faith of the scientist.” The search for a minimum of foundation concepts refers to the search for a simplicity of underlying structure. The search for a minimum of relationships between these concepts refers to a search for a single law or principle which would describe how this simplest of all structures operates. The search for both of these is what is meant by the phrase "the search for a foundation for the whole of science."

Pure science from its very beginnings in the thirteenth and fourteenth centuries was dominated by this search for a foundation for all of science. This search gradually turned toward the two fundamental explanatory hypotheses which were discussed above: mechanistic-materialism and dynamic process. Both of these hypotheses were reintroduced into Western thought with the rest of Greek knowledge.

During the fifteenth, sixteenth, and seventeenth centuries, the new experimental method advocated by Bacon began to bear fruit.[4] In this short period of time, the true genius of Europe began to manifest itself and Europe soon passed, beyond any comparison, the science produced by the classical Greeks. The first two branches of science to emerge were those of astronomy and the branch of physics called mechanics. In 1687, Newton made the first attempt to lay a foundation for all of science.

[4 The year 1543 is accepted by many as the beginning of the cultural era of science. In that fateful year, Copernicus's work on the Heliocentric Revolution of the planets and Vesalius's work on human anatomy were published. Copernicus's work marked the emergence of the physical sciences from the era of philosophy which thus began the era of science. Vesalius's work, on the other hand, marked the emergence of biology from theological domination to the era of philosophy. Vesalius, in rejecting the scholastic's espousal of Galen as the supreme authority in medicine, in effect revived Aristoteleanism with its emphasis on naturalistic observation. The philosophical era of biology, with its emphasis on the method of naturalistic observation, lasted from 1543 to 1895 until the work of Loeb and others rejected the doctrine of holism and introduced biochemistry in its stead which innovation was to begin the scientific era of the biological sciences.]

IV

HISTORY OF FIELD THEORY

DECLINE OF NEWTON'S SYSTEM OF MECHANISTIC-MATERIALISM LEADING TO WHYTE'S UNITARY FIELD-PROCESS CONCEPT

Newton's system was the first attempt to lay a foundation for all of 58
science. The major assumption underlying Newton's system was his acceptance of mechanistic-materialism as the fundamental explanatory hypothesis with which to explain all the phenomena of nature. What were the foundation concepts and what were the fundamental relationships between these concepts in Newton's unitary system? Newton's foundation concepts were two in number: first, mass points of invariable mass which followed laws of motion implicitly, and second, action-at-a-distance between any pair of these mass points. The fundamental relationships between these foundation concepts were those expressed by Newton's law of gravity and his three laws of motion.

The "mass points of invariable mass," or the first foundation concept of Newton's system, at first referred to the center of gravity of large mechanical bodies such as planetary bodies or to the mass center of the mechanical objects of the early physicist's (Galileo) laboratory. With the re-introduction of Democritus's and Lucretius's concept of the atom in 1808 through Dalton's experimental work on the combination of gases, the mass point concept and Newton's system were extended to include atoms and atomistic phenomena. The second foundation concept, action-at-a-distance, first referred to the gravitational attraction between large astronomical bodies and was simply conceived as an undefined kind of "force." It was this "force" which caused the invariants to interact with one another over a distance. These interactions produced the diverse phenomena on the mechanistic level of things. After 1808, this "force" concept was broadened to include phenomena other than gravitational attraction. For example, the attraction and repulsion of the electrified particles of electro-statics and the ordering effect of a magnet on iron filings were also said to be caused by electrical and magnetic "forces" respectively. This "force" concept applied on the atomistic level, however, was just as nebulous and just as undifferentiated a concept as was Newton's action-at-a-distance gravitational "force" 59
concept. It was this action-at-a-distance or force concept that Faraday, Maxwell, and Hertz were to attack on the atomistic level and that Einstein was to attack on the astronomical level. Both of these successful challenges led to the rise of field theory.

Newton's system implied that mechanical bodies have intrinsic properties of motion which they follow implicitly. The invariants interact with one another via the "force" of gravitational attraction which could change the intrinsic motions of the invariants. Thus, in order to explain or predict the past, present, and future movements of a planet in relation to the sun, all one had to do was to determine the mass of the two bodies, determine the gravitational center of both bodies and their speeds, and substitute those quantities in Newton's gravitational equation. The past, present, and future pathways of the astronomical bodies then could be geometrically deduced. With these two foundation concepts and these relationships, Newton's system implied that one could explain and predict all the phenomena of not only mechanics and astronomy but those of the rest of science as well. In retrospect, we know that Newton's system and its subsequent development represented the culmination of the doctrine of Democritus and Pythagoras, the explanatory hypothesis of mechanistic-materialism, in Western civilization.

Newton set forth his doctrine of gravitation in 1687 and it lasted as a basic explanatory hypothesis in the physical sciences until the end of the nineteenth century. As we have already noted, there is a certain "cultural lag" in the other branches of science which are still trying to fit their basic concepts into the mechanistic-materialistic mold. For example, behaviorism, cybernetics, connectionism, and neo-Darwinian genetics are all modern versions of mechanistic-materialism.[2] In the meanwhile, the explanatory hypothesis of the dynamic process was also being applied during this period in biology in attempting to explain the nature and origin of life, but, as we

[[2] In the field of genetics, the mechanistic view speaks of the genetic information in the DNA pattern acting as an "inherited message" which *exhorts its control* over the cell's biochemistry through the production of specific enzymes. These mediate particular steps (chemical reactions) in the chemical order which is the life of the cell. The process viewpoint accepts the mechanical views but asserts they do not go far enough. The genetic order, itself, is the product of an organizing process which exerts an organizational control over the genetic endowment so that over the course of evolution the biological order manifests the intrinsic properties of the organizing process, namely, the channeling of available (free) energy into the most useful channels. The mechanistic viewpoint is at a loss to explain such long range development tendencies which are now established facts as the references below will indicate.]

already noted, the doctrine encountered a seemingly unending series of frustrating failures until well into the twentieth century.

Throughout the eighteenth century, Newton's system was applied to all phenomena with its greatest successes coming in the field that possessed the most firmly established knowledge, namely physics and the fields related to physics. So successful were these applications that they led the eighteenth century systematizers to hope that all phenomena, including history, could be reduced to cases of matter in motion and thus be treated in strict mathematical ways. Among other contributions, Newton's system gave verifiable results for the movement of the heavenly bodies, for the phenomena in the field of mechanics, and gave rise to an apparently complete theory of heat. The latter refers to the development of the kinetic theory of heat which was essentially derived by the application of Newton's concepts to atomic and molecular motions. This was in about 1820. In the decades that followed, the principle of conservation of energy was derived from this kinetic theory of heat. This principle, in turn, led to the concepts involved in the development of the first law of thermodynamics. Shortly thereafter, the second law of thermodynamics was established and interpreted in terms of these mechanical conceptions of heat. It was in relation to the establishment of the second law of thermodynamics that Helmholtz pointed out the fundamental distinction between the two kinds of energy: ordered, available, or “free energy” on the one hand and disordered, unavailable, or “bound energy” (entropy) on the other hand. Both of these concepts played a major role in the development of all the sciences, particularly the biological sciences. We will find below that it is necessary to reinterpret both kinds of energy in terms of field theory in order to advance new concepts of life, mind, and the universe in accord with recent knowledge.

The main failure of Newton’s system came in the interpretations of the facts of electro-dynamics and electromagnetism which we will shortly discuss below. Newton’s’ displacement of Huygens’ wave theory of light by his corpuscular theory was another apparent weak point in his system. Newton’s theory of light was to be displaced by Maxwell who stated that light basically was a field which traveled in the form of a polarized wave. Planck and Einstein later introduced a theory of light that was closely analogous to Newton’s concept.

Newton’s system thus proved quite fruitful. In the eighteenth and nineteenth centuries, the universe was conceived to the composed of solid mechanical objects; cause and effect of a mechanical nature was the chief
explanatory device. The universe and everything in it was conceived of as a 61
machine. These were centuries of mechanical order. Newton’s second foundation concept, however, the action-at-a-distance concept, slowly gave way to a new foundation for the whole of physics: field theory.

The years 1818-1820 can be taken as the beginning of the end of mechanistic-materialism as a basic explanatory hypothesis in science. The fact that a magnet orders iron filings into a particular pattern had long been known. In 1819, Oerstead discovered that electric current flowing in a wire produces a magnetic field around the wire which also exerts an ordering effect on iron filings placed around the wire. In 1820, Faraday discovered the reverse phenomenon which is called electromagnetic induction. When a coil of wire is moved between the poles of a permanent magnet, an electric current is set up or induced in the coil.

In attempting to explain how a magnet or an electric current flowing through a wire orders iron particles into a certain pattern, Faraday began to question Newton’s action-at-a-distance concept which was then being employed to explain the phenomenon. It was long after 1820, however, that Faraday began this line of speculative theorizing. H. Hertz was perhaps the first person to question the force concept on the atomistic level. In fact, he not only questioned the concept but threw it out altogether by developing a mechanical theory of electro-dynamics which did not even mention the force concept. This marked an advance because it brought theoretical attention to the force concept.

Somewhat later, Faraday reintroduced the force concept in an attempt to explain the phenomenon mentioned above. He was asking how a magnet (or an electrical current in a wire) orders the iron filing around itself. By the magnet exerting a “force” on the iron particle? Faraday subsequently answered no. A magnet *created spatial states* around itself which today we call fields. It was this field which then ordered the iron filings around the magnet. In other words, Faraday was suggesting the existence of a new type of entity, a field. It was the interconnecting agent which mediated the interactions between the magnet and the iron filings and it was not simply an undifferentiated kind of force. Faraday's concept of field[2] had to correspond to a degree with the nineteenth century picture of the world. The field was conceived to be a kind of tension or stress in space that revealed 62

[[2] This nineteenth century concept of field in now termed "classical field" as opposed to the newer concept "quantum field." Today it is felt that all fields are quantum fields.]

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itself by the action of its forces on any material objects which happened to lie in the same space as the field. Examples of this kind of field are the electric field which pushes and pulls charged objects and the magnetic field whose effects on magnetized objects are well know from common every day experiences. Faraday's theorizing, despite its mechanical cast, nevertheless marked a significant advance toward what was to become field theory because he ascribed properties (geometric structure and interdependent action) to spatial states themselves whereas heretofore only the material mass points were conceived to possess properties.

The next step in the development of field theory was taken by the Scottish mathematical physicist James Maxwell. Between the years 1864 and 1873 Maxwell formulated the exact mathematical time-space laws of the electric and magnetic fields and thereby created the first field theory in a mathematical form. Maxwell had previously discovered that where a changing electric field exists (in space), a magnetic field must also exist, and vice versa. How then can one describe and predict the electromagnetic phenomena taking place in a particular region of space? Any complete description of the state of the fields in a given space, Maxwell reasoned, must include the strength and direction of both fields at every point in the region separately. Then, utilizing Faraday's mechanical conception of the field, Maxwell further reasoned that any point in the electromagnetic field can be characterized by a vector for each of the two fields, the electric and the magnetic. (A vector represents the strength and direction of a field. It is a line with an arrow, the length of the line representing field strength and the arrow its direction.) An arrow, or vector, in three-dimensional space can be described by its three projections upon three mutually perpendicular axes. Since there are two arrows in the characterization of the electromagnetic field, any point in the field can be described by six numbers, three denoting the electric and three the magnetic field. These numbers change not only from one point to another but also at the same point from one moment to another. The mathematical representation of these electromagnetic "points", their changing magnitudes in space and time, was then derived by Maxwell and has come to be called the Maxwell Equations. (The validity of the equations was experimentally confirmed after Maxwell's death in 1887 by Hertz.) Thus, the localization of the two vectors for particular points in the electromagnetic field at t_1 and t_2 can be determined by experiment and substituted in the Maxwell Equations. The simultaneous integration of Maxwell's six differential equations thus results in a dynamic description of the electromagnetic field in a particular region of space within these 63 temporal limits. Maxwell's equations thus defined the laws of how these functions change in space and time.

This, then, was the classical field: an undefined entity which existed throughout a volume of space and described by sets of numbers which denoted field strength and direction at a single given point in space. In other words, to fit with the then-current view that the universe consisted of mechanical objects, the electric and magnetic fields were visualized as mechanical stresses in a material substance. The material substance was the ether which carried the electric and magnetic stress, the ether being an independent entity which was supposed to fill the whole space.

Maxwell also was the first to realize that these fields could exist completely disconnected from any material objects; i.e., independent of the presence of matter. Another important contribution was Maxwell's apparent discovery (by deduction from his mathematical formulations) that the electromagnetic fields traveled in the form of polarized waves with the speed of light. He guessed (correctly we now know) that light consists of traveling electromagnetic fields.

Maxwell's chief contributions to field theory were two in number. Faraday had stated that spatial states could have interdependent action and properties independent of mass points. Maxwell then made the fundamental contribution of proving that the properties of these spatial states could be described and predicted mathematically. Maxwell, thus, by considering changes in time and three-dimensional space created the first field theory. A mechanical theory is concerned only with mass points and their motions while a field theory is concerned with spatial states and how they change in space and time. Maxwell also made the fundamental point that the spatial states or fields could exist independently of matter. Taken together, the main significance of Faraday's and Maxwell's work was to throw out explanations of electrostatic and electromagnetic phenomena by Newton's action-at-a-distance concept and to replace this "force" concept with field-like viewpoints. Maxwell had deduced that the field (e.g., from the magnet or from the current moving in a wire) spread (to the iron filings) with the speed of light. Thus, Newton's action-at-a-distance force concept at the atomistic level now began to be conceived as a field spreading with finite velocity. After the work of Hertz, Faraday, and Maxwell, there remained of Newton's foundation concepts only material mass points subject to the laws of motion and the action-at-a-distance concept (gravitational attraction) on the level of astronomical bodies.

By the 1880's physicists were becoming more and more skeptical toward 64
Newton's system as the foundation for all of physics, let alone for all of science. Yet, resistance to the new field concepts remained, for nobody could conceive how these field concepts could form a new foundation for all of physics. "Only after Hertz had demonstrated experimentally the existence of Maxwell's electromagnetic waves, did resistance to the new theory break down...Everywhere Newton's action-at-a-distance gave way to fields spreading with finite velocity." (Einstein) So after 1887, the year in which Hertz not only discovered Maxwell's electromagnetic waves but also proved that their velocities and wave lengths could be measured, the whole of

physics began to shift away from the doctrine of mechanistic-materialism as the fundamental explanatory hypothesis for all of science.

In the 1890's, J.J. Thompson pointed out that an electrically charged body in motion, according to Maxwell's theory, must possess a magnetic field whose energy acts precisely as does an increase of kinetic energy of the body. To make a long story short, kinetic energy came to be conceived as a manifestation of a field changing its form. A field has a geometric shape; as the shape changes form, the phenomenon we call "energy" makes its appearance. So energy came to be conceived in terms of fields. This proved to be the real turning point from mechanistic-materialism to field theory because, prior to Thompson's work, energy was regarded as a possible fundamental entity and hence, a rival to matter and field as a possible source of foundation concepts. Thompson's interpretations of energy as a field changing its form and the decline of mechanistic-materialism left the conceptual field entirely to field theory. This was in approximately 1895; the era of a new explanatory doctrine can be said to have begun in science at this date.

So at the turn of the twentieth century, the search for a unifying theoretical system for all of science had led to the conviction that all of man's knowledge could be explained and understood on the basis of one fundamental concept—that of field. But what was the fundamental nature of field? And what are the fundamental laws (or law or principle) that govern the empirical referent of the new foundation concept? Then, how can the concept of field and its laws (or law and principle) of operation be applied to the understanding of matter in physics, life and mind in biology, and the group in sociology? Matter, biological process (life and mind) and the group, it will be recalled, can be said to be the three fundamental concepts of the three major sciences: physics, biology, and sociology. It is these concepts-—their empirical (temporal and spatial) origin, their evolution and 65
ontogenetic development, their interrelations, and their future destiny on this planet—which field theory must successfully explain and predict if a unitary theory is really at hand. It is these major problems that have encompassed the thinking of pure science from the beginning of the twentieth century to this day.

Let us now revert to J. J. Thompson's theoretical discovery in 1895 and trace the history of field theory in the twentieth century. Thompson's discovery that energy can be conceived of in terms of fields led to the idea that if energy can be explained in terms of fields, perhaps the basic property of matter, its mass, could also be explained by field theory. This led to an attempt to explain the then understood structure of matter in terms of Maxwell's conceptions of field theory. This attempt led to failure. Thus, Maxwell's conception of field was not the foundation for the whole of physics. It was for this reason that Faraday's and Maxwell's field theory came to be called "classical" field theory. So at the turn of the twentieth century, physics had two basic problems: how was one to explain gravity on the basis of field theory on the one hand, and, on the other hand, how was one to explain the elementary components of matter, the atoms (and the fundamental particles that were then currently being discovered through research on radioactivity), on the basis of field theory. Since no one knew the basic nature of this new foundation concept it was not surprising that these two problems led to the development of two separate theoretical systems in the twentieth century, each essentially independent of the other and each not being readily assim[il]able to the other. These two doctrines are called the relativity field theory and the quantum field theory. The history of relativity theory and quantum theory in the twentieth century is the history of the progressive displacement of Newton's concepts of action-at-a-distance on the astronomical (gravitational) level and the invariant mass points on the atomistic level by field theory. We will discuss the development of these two theories concurrently.

In the year 1901, Max Planck, engaged in a theoretical research study of black-body radiation, made the epoch-making discovery that the resonators (of Maxwell's electro-dynamics) can not have just any amount of energy and can not move continuously from one energy level to another[3]. Planck asserted that radiation of a given frequency consisted of individual packets of 66

[[3]In accounting for the emission of light waves by an atom, the adherents of Maxwell's theory postulated the existence of tiny electrified particles in the atom which vibrate to and fro and in the process give off light waves of the various frequencies. These particles were to be later identified as electrons. According to Maxwell's theory, these vibrators or resonators all had the same energy regardless of their frequency.]

energy with value hv where h is Planck's universal constant and v the frequency of the resonator. The constant h is determined empirically. The resonators of which all solid bodies consist (and later identified as the orbital electrons) must always be at one energy level or another; to go from one level to another, the resonator must emit or absorb energy in these individual or discrete packets. The distance between levels is, then, an integral multiple of hv and varies as the frequency of the resonators in each case.

Maxwell had suggested that light was basically an electromagnetic field and by deduction from his mathematical formulations he postulated that light traveled as a long continuous train of polarized waves. Thus, the important point of difference between Maxwell's and Planck's conceptions of light was that Maxwell contended that the electromagnetic light-field was a continuous entity (which left the implication that all fields should be continuous entities) while Planck was asserting that the electromagnetic light-field was a discontinuous entity made up of discrete particles called quanta. Planck proved to be right. Planck's new conception of light subsequently led to two viewpoints. One was that on the level of atomistic phenomena the character of events is determined by discrete states and by apparently discontinuous transitions between them. The other viewpoint was the realization that a field could be made up of apparently discrete particles (with the discrete particles possessing "wave" properties) and yet be basically a field. Both viewpoints later merged and led to the interpretation of the apparently discrete particles in the atom in terms of wave-field concepts. This development was to come in the 1920's and is often called "quantum-mechanics." But the term is a misnomer for in these conceptions all vestiges of Newtonian mechanics except its legacy had disappeared including the notion of mathematical law. A more apt descriptive term for this development would be wave-field physics.

Instead of picturing the electromagnetic light-field as a long continuous wave train, after Planck's research physicists came to conceive light as being composed of small bundles of energy (actually small bundles of field) each having a short wave train. (We will have occasion below to further differentiate this conception of light which we shall call "the homogeneous photon hypothesis" in an effort to reinterpret the "red shift" of astro-physics.) Since light, from the new viewpoint, was emitted or absorbed in units of hv, the next logical step was to postulate that light travels in packets
or particles of energy (field) of value hv. Planck never took this conceptual 67
step; it was up to Einstein to do it. In 1905 Einstein had three papers published in the same volume of the *Annalen der Physik*. One of these papers dealt with the action of ultra-violet light striking a negatively charged metal surface, being partially absorbed and thus giving up its entire unit of hv to an electron which is then ejected from the metal and its energy measured. This (discovery of the law of the photoelectric effect) had much to do with the revival of Newton's corpuscular theory of light and is an important step in the development of quantum theory.[4] (We will pick up the thread of the development of quantum theory again when we return to Rutherford's and Bohr's new conception of the atom.)

Another of the papers was Einstein's Special Theory of Relativity in which he presented a new version of Maxwell's field theory but never mentioned the ether. With the abandonment of the ether-filled space to carry the electric and magnetic stresses went also the rejection of the idea of space as a fixed framework within which one can distinguish "true" from relative motion. The speed of light—or traveling packets of energy hv—was the governing constant of the universe. It will always be measured at 186,282 m.p.s., and no moving body can ever exceed this speed. This velocity is independent of the motion of either the source or receiver of the light and is constant with respect to any galaxy in the universe.

The main significance of Einstein's special theory of relativity for field theory was that is was a final blow to Newton's action-at-a-distance concept on the level of astronomical bodies. Let us see how this came about through Einstein's rejection of the other concept. Maxwell, as we noted, conceived the electric and magnetic fields as mechanical wave-stresses moving through a material medium. This material medium was called the luminiferous ether. It was conceived of as a rigid, fixed and stationary framework of material mass points that were spread throughout space. This ether-space framework was independent of the electromagnetic waves which it transmitted much in the same way and manner in which the molecules of air are independent of the sound waves which they transmit by their compression and decompression. Thus, light waves could move through the ether-space but the material points of ether would remain as the fixed framework.[5] The

[[4] The word quantum was originally used to denote the quantity of energy hv and later was also expanded to include the corpuscles of light. In this latter use, the word has become obsolete since "photon" has taken the place of "quantum" in this sense. The word "quantum", however, is still used as a general term referring to the various particles of the atom.]

important significance of the ether concept was that if such a fixed 68
framework of ether-space could be discovered, one could use it as a frame of reference with which to determine all true times, positions, and motions of

objects and events in space. That is, physicists could set up a fixed point in this "stationary frame of reference" to which point the positions, times, and motions of all structures and events in the universe could be referred.

In 1881, Michelson and Morely, by asking whether our solar system moved through this ether-space or if it remained stationary, brought the ether concept to the forefront of physical thought. They reasoned that if the earth were moving through this fixed framework of ether-space, a light wave passing between two distant mirrors ought to spend some time in the light-carrying medium (in the immovable ether) so that by the time a light beam left a fixed point on mirror 1 and traveled to the other mirror and back again to the same fixed point on mirror 1, the beam should be displaced to one side of the point from which it originally left mirror 1. The displacement of course would be due to the earth moving past the straight line that the light beam would describe (in the ether) between the two mirrors if the earth were not moving. (The light beam itself was known to travel at a constant speed which was independent of the motion of the source or the receiver of the light.) After many careful observations with Michelson' interferometer, Michelson and Morely found that, although slight shifts of a beam (so arranged to detect the ether drift) could be detected, no regular shifts of the beam could be detected. There were two possible conclusions which could be drawn from the Michelson-Morley experiment: that there was no such thing

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[[5] When a wave is propagated through a medium it is the disturbance which travels and not the medium itself. Thus, the motion of the material medium—the material points of the ether or the molecules of the air—may be considered as the source of the waves. If one confines his attention to any single point or particle in the medium he will observe that, as the waves move past, the particle moves about its rest or equilibrium position with periodic motion. For light, this periodic motion is up and down so that the material mass points of the ether supposedly vibrate along a line perpendicular to the direction of the propagation of the light. For sound, the air molecules vibrate back and forth in a direction that is parallel to the direction of propagation of the sound. In both cases the material mass points (of the transverse waves) and the air molecules (of the longitudinal wave) remain relatively fixed in space but the wave moves along. We will have occasion to mention standing waves below. Standing waves may be reproduced by two waves traveling in opposite directions or by one wave being reflected back on itself. The loops formed in the standing wave are the points of maximum motion whereas the points of no motion are called nodes.]

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as an ether drift, and hence, by implication, that there was no ether, or that
the Michelson interferometer was incapable of detecting the ether drift. In 69
other words a fixed framework might exist but the instrument used was not sufficiently precise to detect it.

Einstein accepted the null conclusion of the Michelson-Morely experiment and upon this assumption proposed his theory of relativity. Einstein stated that even if a fixed framework in space existed, the Michelson-Morely experiment showed that it could not be detected so for all ostensible purposes it did not exist. So it followed that all true times, motions, and localizations in space were inaccessible to physical measurement. Since no stationary reference point was available, the frame of reference of any measurement must be a point (such as in an observer on earth) whose coordinates can not be absolutely fixed. So all measurements made from this reference point were relative to (that is, dependent for their values upon) this frame of reference. The only true invariant in the universe was the speed of light. We will come back to the significance of this new viewpoint for Newton's action-at-a-distance concept in a moment.

Other scientists, after the Michelson-Morely experiment (and some to this day) accepted the second conclusion of the experiment: that a fixed framework in space remains to be discovered and that the interferometer simply failed to detect it. Reasoning along this line led to the ideas which have come to be called the Lorentz-Fitzgerald Contraction. If objects moving through space have to push against the immovable ether, Fitzgerald suggested in 1890, then such objects would be compressed in the direction of motion. This compression would therefore shorten the Michelson interferometer and might exactly compensate for an existing ether drift. Lorentz, on the other hand, proposed that the ether, instead of being made up of material points, was an electromagnetic ether which acted upon atoms and molecules moving through it thus forcing them to move closer together. These two concepts together are called the Lorentz-Fitzgerald Contraction. This essentially states that an increase in the velocity of a body is accompanied by an increase in its mass and a decrease in its length. Such a contraction, however, has never been observed; yet, Einstein showed that the Lorentz-Fitzgerald Contraction might indeed be a reality for he independently derived the contraction idea from his relativity equations. The reason this shortening of an object cannot be measured and, hence, observed, Einstein held, is because if one were on a moving object attempting to measure its length, the measuring stick would also shorten by the same relative amount.

Thus, Einstein demonstrated that the Lorentz-Fitzgerald Contraction 70
could be interpreted in terms of relativity theory. This incorporation of the Lorentz-Fitzgerald idea into relativity theory, however, was actually presumptive evidence against the ether concept and left the possibility of discovering a fixed framework in space more remote than ever. We will have occasion below to question the Michelson-Morely experiment and Einstein's rejection of the fixed framework conception. We shall also reinterpret the Lorentz-Fitzgerald Contraction in unitary terms in order to advance the new concepts of matter and the universe which we shall develop from the unitary viewpoint.

Newton's action-at-a-distance concept held that in order to explain the action of two masses on one another, it might be possible for an observer to state the location of the two interacting masses at the exact same time. In other words, in order to be able to substitute the center of gravity of two astronomical bodies in Newton's gravitational equation, it was necessary to know the position in space of both bodies simultaneously. Einstein argued that Newton's doctrine attributed an absolute character to an observation of simultaneity whereas such an observation really depended upon one's position with respect to the two events being observed. Prior to Einstein's time, it was believed that once an event occurred in a particular strata of time, it was forever fixed or positioned in this strata. Thus, from this point of view, any observer, no matter his position with respect to this event, has to observe the event in a particular strata of time or not at all. Thus, this implied that time, like the fixed framework in space, was an invariant. But this is not the case, Einstein maintained. Time (and thus the simultaneity of events) is relative and not invariant. For example, to an observer situated

halfway between two simultaneous lightning bolts, the lightning bolts would appear simultaneous, but to an observer situated at one side of the two flashes, the bolts would be experienced as two successive events. In this example, no matter what is calculated about the speed of light, it remains that the same two events can be simultaneous from one point of observation and successive from another point of observation. This is what is meant by the assertion that simultaneity is relative and not invariant. Time is a dimension that must be considered in localizing events in space. Thus, Einstein's special theory of relativity was a final blow to the action-at-a-distance hypothesis. Einstein had demonstrated that Newton's requirement of absolute simultaneity of events could not be met (for simultaneity was relative and depended upon the frame of reference) and that new equations
had to be derived to remove the discrepancy.[6] Since Einstein's new equations 71
were field equations, another important contribution of Einstein's work to field theory was to suggest that field concepts could be applied equally as well on the cosmological (astronomical) level as they were being applied on the cosmogonic (atomistic) level. This implication, for example, has recently led Hoyle to assert that the steady-state theory of the universe could be understood and explained on the basis of Einstein's field equations.

We already learned that Planck (in 1901) had to employ a quantum hypothesis (instead of Maxwell's continuous-wave concept) to explain the emission of radiant heat from hot bodies as a function of temperature. Einstein also used this hypothesis to explain the photoelectric effect we described above. Then in 1913, Niels Bohr went to the University of Manchester to study with Ernest Rutherford who had just conceived of the atom as a miniature solar system in which the electrons are the "planets" revolving around the positively charged nucleus "sun." (The concept of the atom previous to this is sometimes called the "billiard ball" atom because it was conceived as not having an internal structural differentiation.) Rutherford did not prescribe a particular orbit for the electrons; Bohr took this conceptual step. Bohr assumed that the angular momentum of the hydrogen atom, for example, was quantized and the electron may revolve only in certain orbits which have to be integer multiples of h/2. When the electron moves from one orbit to another immediately adjacent, a single photon is emitted (if it moves to the lower level) or absorbed (if it moves to the higher level). Thus, Bohr was postulating that light is emitted or absorbed by an electron only when the electron jumps from one orbit to another. The frequency of this light is not determined by the frequency of revolution of the orbital electron but by the difference in energy level between its initial and final orbit.

The classical (Maxwellian) conceptions of the atom allowed orbital electrons to move at any distance from the nucleus and put no restrictions on the eccentricity (elongation) of their orbits. Bohr's fundamental contribution, the notion of discrete quantum orbits (that is, the electron had to move in definite and discrete orbits defined by the quantum conditions alluded to above), drastically reduced the numbers of permitted states of

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[[6] In this section and others below, we shall point out a distinction between "physical" and "psychological" time. For the former but not the latter, we will maintain that events in space such as simultaneity can be described in absolute terms because such time-events produce certain modifications in structure which can be studied after the time-event has passed. This, in effect, would remove the observer from the observation and reject the notion that time is necessarily relative.]

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motion of the orbital electrons. For the classical notion of infinite 72
trajectories for the orbital electrons, Bohr offered a model of the atom which included specific circular and elliptical orbits for the atom which were supposedly sharply defined. Both the concept of discrete orbital electrons and Bohr's concept of sharply defined orbital trajectories were to be subsequently rejected by the quantum-wave physics of the next decade.

(We will have occasion below to reinterpret the concept of angular momentum and we shall trace the source of the intrinsic motions of Newton's "mass points" to the intrinsic properties of the unitary field. We will set forth the idea that the types of motions in the atom afford us an invaluable cue as to the age of the astronomical bodies from whence a particular atom was emitted. Inter- and intra-atomic motions, it will be maintained, are as important an indicator of the passage of time as are the ratios of decayed and un-decayed residues of radioactive substance. The conclusions we will draw about these atomic motions, moreover, will be the exact reverse of those drawn by modern statistical thermodynamics.)

Bohr's orbital model of the hydrogen atom gave an equation that not only accounted for the Balmer series of lines of the hydrogen spectrum for which Bohr originally attempted to account, but it also led to the prediction of three other series of lines in the excited hydrogen atom spectrum, all of which were later experimentally discovered. The four series of lines essentially result from electrons jumping from the highest energy (orbital) level to either the: first, second, third, or fourth innermost (lowest) energy levels. The energy level of the four series of lines thus is directly proportional to the orbital "distance jumped" by the high-energied electrons.

Bohr's concepts are no longer taken as precise indications of atomic reality but they are apparently close enough approximations of that reality to be extensively used by chemists in their attempt to understand the binding forces within molecular compounds. Perhaps the most important contribution made to field theory by Rutherford's and Bohr's new conceptions of the atom was to differentiate the "billiard-ball" concept of the atom. This led to the increased conviction that the invariant mass points, Newton's first foundation concept, even at the most fundamental level of the atom, were not invariant entities at all. This was an anticipation of the discovery of a whole host of minute nuclear particles each of which are more fundamental (structure-wise) than the atom itself.

In the meanwhile, Einstein was propounding his General Theory of
Relativity in the years 1915-1920. (The special or restricted theory of 73
relativity applies only to bodies moving with constant speed, whereas the general theory applies to bodies moving under acceleration.) This theory put forth a new concept of gravitation; abandoning Newton's concept of gravity as a force, Einstein conceived that the space around any celestial body is a gravitational field much like that around a magnet is a magnetic field. He then concluded that the presence of a gravitating body bends the particular regions of space in which it lies. Light rays passing through this "bent space"

would then travel not in a straight line but in curves. Four years later during an eclipse of the sun (1919), astronomers confirmed this conclusion and again in 1922. However, in 1929 the agreement was not satisfactory.[7]

That gravity is a field like any other field is now generally accepted by physicists. It should be noted that in Einstein's general theory of relativity the new concept of the gravitational field acquires the status of "space." This role was ascribed to the "ether" in Maxwell's system. Thus, light traveling through this "gravitational space" can be bent. This is due to the bending of the gravitational field near the surface of massive bodies. Light apparently follows the contours of this bent "gravitational space." Einstein's concept of "gravitational space" has been extrapolated to the "space of the universe" (by Gamow and others) so that certain conclusions can be drawn about the shape of the universe. Thus, if one accepts this view of "gravitational space" and either Newton's hypothesis that matter is spread uniformly throughout space or the more established fact of observational cosmology that galactic groups are uniformly distributed throughout space, one can conceive that the universe is bent at its borders in such a way that we have a finite universe. (There are other possibilities.)

According to Gamow's cosmological viewpoint, the cosmic system of galactic groups of the universe can not be expected to remain static because of gravitational attraction. The galactic groups and, hence, the universe as a whole, must either contract under the forces of gravitational attraction or expand as the result of some dispersing force overcoming the attraction. For the past few decades, Gamow and a majority of astro-physicists and astronomers have accepted a recessional hypothesis which asserts that the

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[[7] More recently there is E. A. Milne's Theory of Kinematic Relativity in which he holds that not all observers are equal but only those who are similarly related to the large-scale distribution of matter and motion in the universe. Thus, if the matter of the universe is concentrated into galaxies, those observers situated at the nuclei of galaxies would be equivalent only to observers also situated in the nuclei of galaxies.]

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universe is expanding. The adherents of this recessional hypothesis 74
maintain that five to ten billions years ago the universe was in a superdense state which then exploded, the force of this primordial explosion being the source of the dispersing force that has kept, and now keeps, the galactic groups apart. As experimental proof of this viewpoint, the expanding-universe theorists point to the extra-galactic red shifts (which they interpret on the basis of the Doppler principle) which seems to indicate that nearly all the galaxies of the observable universe are directed outward from any arbitrary reference point taken in space. (There is no doubt of the reality of the red-shift nor is there any doubt that a good correlation exists between the amount of red-shift and galactic distances but the interpretation that the red-shift means that galaxies and galactic groups are receding from one another is open to question.) Gamow has also extended Einstein's idea of curved space to explain why cosmic rays (actually atomic nuclei) come into the atmosphere of our planet in all directions. Since the creation, Gamow states, these cosmic particles, instead of traveling in straight lines, have been traveling along curved (gravitational) trajectories. Occasionally, some of these particles become entrapped in the earth's gravitational field and

enter our atmosphere. Since these particles are traveling more or less randomly through space, their random entry into our planet's atmosphere is thus accounted for.

As already indicated above, a new concept of space, that of a fixed-framework nature, will be offered below. This new viewpoint will implicitly reject Einstein's "gravitational space" concept. We will, moreover, combine Einstein's concept of gravity as a field with both quantum concepts of the graviton and unitary gravitational concepts. This will lead to a new concept of how the gravitational field operates. The gravitational field will possess the attributes ascribed to it by Einstein (but without the gravitational-space feature) and quantum theory plus a dispersal property ascribed to it by unitary theory. The dispersal property which we shall attribute to the gravitational field is an intrinsic property of the unitary field. Every field structure in the universe manifests this dispersal property to some degree (most in the form of a high level of free energy) but due to the peculiar structural properties of the graviton, the graviton manifests this dispersal property to the maximum degree. It is this dispersal property that is the primary property of the gravitational field and it is this dispersing tendency which "gravitational attraction" counter-balances. This symmetry tendency of the gravitational field prevents maximum dispersion (of the physical
systems) instead of the other way around as Gamow envisions it[8]. (It is of 75
interest to note that it was Einstein who originally introduced an idea of a "cosmic repulsive force" to account for a dispersing force in the universe but he later rejected the idea.) We will use this viewpoint of the gravitational field to advance a new theory of the universe which is closely analogous (with two major exceptions) to the steady-state theory of the universe. We will then proceed to reject both the "cataclysmic explosion" hypothesis and the recessional hypothesis. We will reject the former concept on the grounds that the new view of gravity accounts for the dispersal tendencies between galactic groups and also on the grounds that the "big-bang" hypothesis constitutes a spontaneous generation hypothesis. We will reject the recessional hypothesis on the grounds of the mechanical interpretations of the red-shift. We will maintain that the Doppler-principle interpretation of the red-shift is a legacy left over from Maxwell's interpretation of fields as mechanical stresses which, hence, could have "wave" properties. The red-shift, from our viewpoint, will simply signify that as photons travel to our planet from a far distant galaxy, they lose field-energy which causes the red-shift. Since we must reject the notion of a curved space, we must also reject Gamow's explanation of why cosmic rays enter our atmosphere in a random fashion. In fact, we will point out that cosmic rays are indices of where we can discover the formative process which is forming physical systems in our galactic group at the present moment. We shall so phrase this viewpoint as to constitute a test of sorts of unitary conceptions on the astronomical-physical level.

There are limitations of Einstein's relativity field theory as a foundation for the whole of physics. The following is Einstein's evaluation of his own position:

> But it can not be claimed that those parts of the general relativity theory which can to-day be regarded as final have furnished physics with a complete and satisfactory foundation. In the first place, the total field appears to be composed of two logically unconnected parts, the gravitational and the electromagnetic. And in the second

> place, this theory, like the earlier field theories, has not till now supplied an explanation of the atomistic structure of matter. This failure has probably some connection with the fact that so far it has contributed nothing to the understanding of quantum phenomena.

Einstein set forth this General Theory of Relativity in the years 1915-20. Despite the successes of many aspects of this theory (which continue to this

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[[8] The dispersal property of the graviton is always the dominant process and is counter-balanced by the reverse tendency, the accelerating effect that is commonly ascribed to gravitational attraction. This dispersal property of the graviton, it will be postulated below, is closely related to the unitary views on atomic motions.]

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day), by the early twenties a number of physicists realized that Einstein's 76
field equations could not serve as the fundamental laws for the foundation concept of the field. Einstein's theory was a rigidly deterministic type of field theory but research on the atomistic level had already begun to show that all objects of atomic size continually fluctuate; i.e., they can not maintain a precisely defined position for a finite length of time. This meant that strict causality must be abandoned; hence, Einstein's field equations do not and can not suffice to explain micro-physical phenomena. Perhaps the fundamental contribution of field theory by Einstein's General Theory of Relativity was to further differentiate the foundation concept, the field. Let us briefly recapitulate this evolving foundation concept up to, and including, Einstein's contribution.

The concept "field" refers to spatial states which have geometric structure. These geometric field structures[9] display interdependent action in space and time. (Interdependent action in space and time means that a disturbance in one part of a field at a particular moment spontaneously brings about adjustive changes in the whole field at the particular moment or at some other future moment or moments.) The properties of these spatial states (geometric field structures) can be mathematically described and their interactions with "mass-points" mathematically predicted. On the atomistic level, there are at least two basic types of field structures, the magnetic and electric; but the two are (or can be) interconnected to form the electromagnetic field structure. The geometric structures of these spatial states can spontaneously change their form and in the process of so doing they manifest the force properties previously ascribed to "energy." These spatial states of field structures are the interconnecting medium between apparently unconnected "mass-points" and operate on the principle of least action. It is these spontaneously changing field structures of these spatial states that cause the interactions between these "material" entities. The field structures of these spatial states can be concentrated to form discrete particles such as the photons. Field concepts can be applied equally well on both the atomistic and astronomical levels. Space and matter are themselves either special kinds or special forms of these spatial field structures. To these ideas Einstein added that gravity itself is a field; it is the interconnecting and interacting link between astronomical bodies. The force properties previously ascribed to "acceleration" are actually a manifestation of the gravitational field structures spontaneously changing their form. 77

[[9] Actually the idea of field structures was only implicitly present in the field doctrine. The concept is used here to make these doctrines more qualitatively intelligible.]
