A Ripple in a Field

Like other things one does not talk about, unclear thinking about what is fundamental can come back to haunt us later on. Its most insidious effect is to lead us out into the desert by inducing us to search on smaller and smaller scales for meaning that is not there.[1]

You think because you understand *one* you must understand *two*, because one and one makes two. But you must also understand *and*. (Ancient Sufi teaching)[2]

The Challenge

In the introduction to an otherwise brilliant discussion of the unavoidable natural constraints placed upon the possibilities of unlimited economic growth, Hermann Daly addresses the confrontation of scientific determinism with religious morality. In speaking of a prior meeting at which major scientific figures had sought to marshal the support of religious leaders for a campaign to preserve the Earth from the inevitable ravages of an essentially uncontrolled economic system, he observes:

> Sagan, Wilson, and Gould proclaim the cosmology of scientific materialism, which considers the cosmos an absurd accident, and life within it to be no more than another accident ultimately reducible to dead matter in motion. In their view there is no such thing as value in any objective sense or purpose, beyond short-term survival and reproduction, which are purely instinctual and thus ultimately mechanical. Calling for a moral compass in such a world is as absurd as calling for a magnetic compass in a world in which you proclaim that there is no such thing as magnetic north. A sensitive compass needle is worthless if there is no external lure toward which it is pulled. A morally sensitive person in a world in which there is no lure of objective value to pull and persuade this sensitized person toward itself is like the compass needle with no external magnetic force to act on it.
>
> One might reply that objective value does not exist externally, but is an internal affair created by humans (or by God in humans only) and projected or imposed by humans on the external world. This is the solution of dualism, and has been dominant since Descartes. Purpose, mind, and value enter the world discontinuously in human beings; all the rest is mechanism. Such a view, however, is contrary to the evolutionary understanding of kinship of human beings with other forms of life that is affirmed by science. For mind, value, and purpose to be real, they must, in an evolutionary perspective, already be present to some degree in the world out of which humans evolved, or else they must be the object of a special creation. The latter, of course, is not acceptable to science and the theory of evolution. Scientific materialism resolves the dilemma by denying the reality of purpose, mind, and value in human beings as well as in the external world. The subjective feelings that we refer to as purpose or value are mere epiphenomena, ultimately explainable in terms of underlying physical structures and motions.
>
> The main alternative to scientific materialism, one that still takes science seriously, is the process philosophy of Alfred North Whitehead. This view is radically empirical. What we know most concretely and directly, unmediated by

the senses or by abstract concepts, is our inner experience of purpose. That should be the starting point, the most well known thing, in terms of which we try to explain less well known things. To begin with highly abstract concepts such as electrons and photons, and to explain the immediate experience of purpose as an "epiphenomenon" incidentally produced by the behavior of these abstractions, is an example of what Whitehead called "the fallacy of misplaced concreteness." I do not wish to pretend that Whiteheadean philosophy is easy, or without problems of its own, but merely to say that for me it strains credulity a lot less than scientific materialism.

Gould himself has noted, "We cannot win this battle to save species and environments without forging an emotional bond between ourselves and nature as well—for we will not fight to save what we do not love." But is it possible to love an accident? Rather, is it possible for an accident to love an accident? For an accident to fight to save another accident? I doubt it, but I do not doubt that it is possible for people who call themselves scientific materialists to fall in love with the world they study and have come to know intimately. God's world is lovable, and scientists often fall in love with it much more deeply than theologians! But should they not confess that love, and ask themselves how it is that they could have fallen in love with something their science tells them is an accident? In their daily life are they particularly fond of random events, or do they find them annoying? There is something fundamentally silly about biologists teaching on Monday, Wednesday, and Friday that everything, including our sense of value and reason, is a mechanical product only of genetic chance and environmental necessity, with no purpose whatsoever, and then on Tuesday and Thursday trying to convince the public that they should love some accidental piece of this meaningless puzzle enough to fight and sacrifice to save it.

The absurdity is highlighted by the scientists' recognition that they have nothing to appeal to in their effort to rouse public support other than religiously based values that they themselves consider unfounded! Are they not temporarily living by the fruit of the tree whose taproot they have just cut? As . . . [one religious participant] puts it,

> Such thinkers consider any vision of purpose in the universe to be archaic and illusory. . . . Indeed it *is* rare to find scientists, literati or philosophers publicly claiming that our universe has any point to it or that any transcendent purpose influences its evolution. But can this cosmic pessimism adequately nourish the vigorous environmental activism that many of these same thinkers, now hand in hand with members of the religious community are calling for today?

To call this a "quite ingenuous proposal," as . . . [he] does, is to be kind. . . . It is indeed a paradox that people whose professed beliefs give them no good reason to be environmentalists are usually trying harder to save the environment than are people whose beliefs give them every good reason to be environmentalists! The scientists are implicitly calling for a religious reformation, not just a moral compass that magically functions in an amoral universe—to point the scientists in the direction of public funds to save the environment.

As Alfred North Whitehead observed,

> Many a scientist has patiently designed experiments for the purpose of substantiating his belief that animal operations are motivated by no purposes. He has perhaps spent his spare time writing articles to prove that human beings are as other animals so that purpose is a category irrelevant for the explanation of their bodily activities, his own activities included. Scientists animated by the purpose of proving that they are purposeless constitute an interesting subject for study.[3]

I have quoted the above passage at length because in it a distinguished contemporary intellectual sets forth in moving terms the moral options legated to us by our more or less taken-for-granted metaphysical frame. While most scientific thinkers rarely confront the issue as honestly and forthrightly as does Daly—often tending, with evident awkwardness, to blur the lines of confrontation, seeking to have it both ways, when they feel compelled to address the issue at all—they almost inevitably come down, in effective practice at least, on the side of that scientific materialism that leaves no place for freedom, purpose, or value. Finding this conclusion unacceptable, Daly feels he has no choice but to opt for a transcendent religious belief, for which he then grasps for the seemingly most plausible philosophical framework with which he can maintain its rational coherence with the most advanced results of modern science. What other choice does he have with which he can preserve a place for freedom and value in a world of materialistic determinism? Given our culturally legated metaphysical frame, the answer is clearly and emphatically, *none!*

Confronting Reductionism

In a practical expression of the prevalent taken-for-granted scientific worldview, we frequently hear researchers say or only suggest that they have found a chemical or neuronal pathway that causes a specific behavior; therefore, by implication if not explication, the behavior is not caused by attitudes or personal psychology. There is a growing tendency among researchers in the natural sciences (not to speak of medical practitioners and the lay public) to assume that if they find chemical or neurological factors that influence behavior (for depression, schizophrenia, hyperactivity, aggression, and the list goes on), this proves that the behavior is materially caused, and that attitudes and values, psychology and sociology, are at best epiphenomenal explanatory systems—products of an incomplete scientific reduction.[4]

Underlying such an approach is an almost universally shared perspective that an event is either materially determined or psychically determined, but not both—for otherwise, how would they interact? For most scientific observers, these alternatives are usually only explicitly posed in order to better refute the dualist and idealist alternatives, thus establishing the sole priority of a reductive materialist interpretation.[5]

As witnessed by Daly and colleagues, but having much broader (and usually less sophisticated) appeal, there is, of course, the alternative move of religious, spiritual, and "new age" thinkers who seek to discredit the materialist interpretation in order to instantiate an opposed transcendent and spiritual one. They seek to defend an essentially idealist interpretation of the world that will justify anything from individual freedom and the objective reality of purpose and values to reincarnation, eternal life, and even psychokinesis, telepathy, and teleportation. Of course, at its philosophical root, Christianity, Judaism, Islam, Hinduism, and (to a major extent) Buddhism are all rooted in a similar metaphysical idealism. (In a lecture on cognitive science, John Searle reports being surprised to hear the Dalai Lama present a Buddhist view of the world that was straight Cartesian dualism—without any reference to Descartes himself.)

Thus, either we find the world divided between two completely incompatible metaphysical orientations, each of which is essentially monistic and reductive, or we are left with a completely implausible dualistic amalgam. The vast majority of the world's people believe in a religio-idealist interpretation that is fundamentally inconsistent with the scientific worldview that provides the foundation for the technological developments by which we all increasingly live. But it is this very spiritualistic approach that grounds the world's ethical systems, and sustains human beings' sense of the meaning and dignity of their lives and the possibilities of their having some effective control over their daily life.

On the other hand, it is quite clear that the world's institutional, economic, political, military, and scientific activities are increasingly guided by a scientific or technical worldview that is essentially materialist and reductionist, effectively denying personal choice and human freedom, while practically developing increasingly refined ways of manipulating and controlling human experience and subtly denying it the philosophical legitimacy to resist.

We see this in every sphere, from the approach to mental illness to the explanation of the nature of life. But is this polarized perspective necessary? Are the theoretical alternatives posed by Daly the only ones possible? Or may they not be the dead-end box into which that metaphysic has unjustifiably placed us? Daly has made poignantly clear some of the fundamental issues that are at stake here. I have already suggested some crucial fault lines in the theoretically dominant perspective. It is for me now to pick up this line of argument and directly address the problem and offer an alternative metaphysical frame for its possible solution. That frame will involve the development of a naturalistic and nonreductive field theory, providing the foundation for a doctrine of emergent qualities and powers that can place our understanding of the world on a more sure and productive foundation. Somewhat in the spirit of Richard Rorty, let me suggest that we "try thinking of [the world] this way."[6]

Addressing Purpose in Nature

The first thing to note is that human behavior is apparently purposeful, while objective nature has long been thought to operate in accordance with mechanical laws. Certainly in the post-Newtonian world, the mechanical clock was long taken as the model for physical interactions. David Hume often had recourse to the similar operating system of interacting billiard balls, with their resultant behavior being a completely determinable consequence of their inertial mass and momentum, modified by the resistance of the medium.

There can be no doubt about the experimental and technical success of the Newtonian system, from industrial developments to war and space exploration. Yet it is human beings that develop these theories and implement their technical applications in accordance with thought processes that clearly do not seem to follow any such deterministic processes. It has, for example, never been clear how the Newtonian system can account for the purposeful scientific investigations of Isaac Newton himself. As Roy Bhaskar insightfully observes, "it is only a non-reductionist metaphysics that can bring itself within its own world view."[7]

Clearly human beings experience the capacity to think, weigh alternatives, make free choices, and even experience anxiety about the possible consequences of these alternatives. Jean Paul Sartre well captured this experienced duality with his phenomenologically descriptive categories of the "In Itself" and the "For Itself," by which he divided up *what is.* In updating the Cartesian dualism of extended substance and thinking substance, Sartre clearly eschewed any attempt to account for the origin of these two distinctive modes of being, simply asserting that we find these two opposed and irreducible qualities in experience. The task of his "phenomenological ontology" was to describe extensively and in detail their modes of interaction. In describing these modes of being, he claimed that the In Itself followed deterministic laws, being completely predictable, while the For Itself was essentially defined as a self-conscious freedom for whom the world appeared as a field of possibilities.[8]

Of course, at one level, Sartre is quite right. That *is* the way our experience appears. And that appearance needs to be accounted for. But does that appearance ultimately make theoretical sense as an adequate foundation? While traditional dualism has never been able to explain the manner of interaction between the fundamentally opposed substances of thought and extension (i.e., mind and body), Sartrean thought seeks to avoid that problem with its noncausal approach, thus also eschewing any investigation into the knotty problem of the origin of this dualism. Meanwhile, it still fails to deal with the original dilemma by fudging the question of the relation of the free conscious subject to the body that seems to be its material precondition. It thus leaves its freedom dangling in thin air, a metaphysical surd without roots or a home in the universe. Perhaps this is a historically appropriate expression of a culture whose preindustrial roots have been torn asunder by industrial development and the world market, but it is hardly a philosophically adequate theory of being.

If, on the other hand, we take seriously the astounding development of human technical and theoretical capacity that constitutes pragmatic proof of the power and essential validity of modern science, we must come to terms directly with its operative materialist assumption.[9] Either we need to accept it, and then show how thought can be reduced to the terms of a materialist science, or, since dualism won't do, we need to provide an alternative framework that makes sense of thought as an emergent property of nature itself.[10] The challenge before us will be to show why the prevalent materialist reduction is inadequate (and ultimately incoherent), while the doctrine of emergence can not only do justice to the facts, but also provide a means for coherently addressing the problem of freedom, and its relation to determinism.

The Problem of Calculation, Measurement, and Predictability

Let me first be clear. My concern is *not* with the practical or technical problem of the impossibility of now—or, almost certainly, ever—actually performing the necessary calculations to provide the definitive predictions that the deterministic model invites. I will first say a few words as to the reasons for that practical impossibility intrinsic to the deterministic model itself. But even showing that would provide no justification for emergent levels of being. It would only codify the limitations of our knowledge and our capacity to predict and control existence. Important as such chastened hubris may be, it would in no way diminish the conceptual plausibility of the reductionist project. My intent goes deeper—and seeks to recast the entire conceptual framework, thus providing coherent and rationally defensible grounds for, among other things, consciousness, freedom, and morality. But let me first briefly address the technical limitations to measurement and predictability. I draw upon the discussion of Brian Silver in *The Ascent of Science.*

It was the Enlightenment thinker Pierre-Simon Laplace who explicitly drew out the deterministic cosmological significance of the Newtonian worldview. Since "Newton's laws completely determined the motion of all bodies, if we could at any moment measure the position and velocity of every particle in the universe, we could use the laws of motion to determine their future motion completely."[11] Similarly, we could also specify the universe's entire past history, thus leaving nothing to either chance or ignorance. But how would one even begin to calculate the exact position of every particle? Consider, for example, the behavior of gas molecules.

> In one second a molecule in the air makes several billion collisions; a tiny change in the direction of our molecule at the beginning of its journey may only slightly alter the way in which it makes its first collision, but that will slightly alter the direction and speed with which it carries on after the collision, *and* slightly alter the subsequent movement of the molecule that it hits. After very few collisions our molecule, and the molecules in its vicinity, will have entirely different positions and velocities from those that we predicted. After 4 billion collisions the molecule is likely to be in an entirely different place from that originally calculated. It is easy to believe that the effect of an extremely small change in initial conditions will have an effect which is out of all proportion. What we are seeing is an extremely simple example of the fact that: *There are systems in which the outcome of a series of events is very sensitive to the initial conditions. So sensitive that the behavior of the system may be unpredictable in practice, even if it is predictable in theory.*[12]

Of course, with a body of enclosed gas we may be able to average out the behavior of molecules in order to produce an average behavior of the system (which has important implications pointing toward the stratification of science and reality), but this is clearly not possible for meteorological conditions. The problem is in fact far worse. As Silver reports:

> An extraordinary illustration of this sensitivity is provided by the calculations of the physicist Michael Berry, who considered a collection of oxygen molecules at atmospheric pressure and room temperature. He placed an electron at the edge of the known universe (about 10^{10} light-years away and asked: After how many collisions would a given molecule miss a collision that it would have had if the electron were not there? Now the electron is supposed to act only via its *gravitational* field, which as you know must be so incredibly small that any right-thinking scientist would completely ignore it. Bad mistake! After fifty-six collisions the molecule misses a collision. I find this result to be almost incredible,

> but you can see why any attempt to predict the microscopic future of molecular systems requires a macroscopic amount of optimism.[13]

Silver concludes his more extended discussion by noting "the impossibility of completely specifying the initial state of a system (in our case the position of a molecule) and the extreme sensitivity of the future development of a system (the path of the molecule), to its initial state (the position of the molecule)." It was considerations such as these that led to the development of chaos theory. "Chaotic processes are . . . unpredictable *in practice* because of their oversensitivity to initial conditions," though "unpredictable processes need not be chaotic," like the toss of a coin. But "the fact that we have no hope of predicting the behavior of chaotic systems does not mean that they are not deterministic." Thus, chaos theory leads to "the collapse of *practical* determinism and the realization that there are insoluble problems within the framework of deterministic science."[14]

This problem is only exacerbated by Poincaré's demonstration that "*in principle* there is no analytical solution to the three-body problem. . . . For a problem involving three, or more, interacting moving bodies, there is no closed solution, no simple mathematical expression."[15] This might be taken as intrinsic theoretical substantiation of the fundamental inadequacy of linear causal thinking, and a practical exemplification of the indispensability of field-theoretic considerations, of which more will be explained later. We have, of course, said nothing here of the fundamental indeterminacy revealed by quantum mechanics, nor of the intrinsic incompleteness of mathematics as demonstrated by Kurt Gödel.[16] So much for the impossibility of practical determinism, but what of its theoretical foundations?

The Reductio of Reductionism

Let us take it from the beginning, in the simplest terms. We experience free choice and a world in which much is quite predictable. Our freedom provides the basis for our ascription of moral responsibility, and the justification for our punishment of those who violate laws and moral obligations. It also grounds our sense of dignity and self-worth, and provides the basis for hope that we may be able to contribute to making our life better. At the same time, we have increasing evidence of the power of science not only to explain but also to produce, reproduce, and transform the material world. It is this very power that provides our free choice with a vastly expanded terrain for action and aspiration. But that science also provides us with theories and strategies for intervention that can radically transform who and what we are and do. Medicine can repair broken parts, pharmacology transform our mood, thought, and behavior—without as of yet any definable limits—biological engineering reconstruct our very genetic constitution, and information processing possibly technologically reengineer human biology.

Further, this same science describes, on the macroscopic level, a material universe that has probably existed for some 13.7 billion years, vastly expanding to truly astronomical dimensions with little evidence for the existence of life, not to say, mind or spirit, throughout vast reaches of time and space. In fact, as far as we know at present, any life, not to say complex life forms or mentally developed ones, only exists on this relatively minor planet revolving around an ordinary star located far off center in an average galaxy that is but one of the billions of galaxies that spread out from here well beyond a distance of 10 billion light-years. Certainly there is nothing special about our material place in the universe. Certainly there is little rational basis to claim that spiritual forces have had anything to do with those natural processes by which our Earth came into being some 4.5 billion years ago.

As General Relativity plays this development back to its origins, it supposes the universe to have emerged out of a gigantic initial explosion called "the big bang." At that initial moment of infinite mass-energy density and space-time compression, there were not even protons and neutrons, not to speak of atoms, molecules, light, things, minerals, plants, animals, or minds. Out of this "quark soup," literally everything has developed.

Now if we are to take the reductionist paradigm seriously, what it must be claiming is that "there is nothing new under the sun," or to be more exact, that everything—the Sun included—can be explained and in essence reduced to and, in principle at least, predicted from an analysis of that initial moment: the theory of that moment could in principle explain and predict everything that has followed. Thus, any qualities, properties, capacities, or attributes that have emerged to constitute the universe are "nothing but" versions of that initial "soup" that can be fully explained by using the terms and laws that explain that event. This must also mean that any concepts that describe emerging properties and powers must be capable of being completely replaced by concepts that only describe those initial events. For example, all thought processes must be completely describable in terms of the not yet developed but eagerly sought for theory of quantum gravity, or some equivalent thereof.

To add to this challenge posed to materialism, we must also take into consideration the problems posed by the Heisenberg Uncertainty Principle—to a very brief consideration of which we will return later—that rules out in principle the possibility of deterministic predictions of single quantum events. Its particular relevance at this point lies in the fact that the initial conditions of the big bang are probably best understood as a singular "quantum" effect, hence, in principle, indeterminate.[17] Thus, a complete materialist reduction, at best, must assert the complete randomness of the fundamental structure (and possibly laws) of the supposedly deterministic universe. The extremes of this position are suggested by investigations of the Cosmic Background Explorer Satellite (COBE) and the Wilkinson Microwave Anisotropy Probe (WMAP) that have tended to confirm the view that the very existence and structure of the galaxies is the result of initially indeterminate random quantum fluctuations at the moment of the big bang.

For reductionists, therefore, either everything is causally present at the initial moment of creation or something "new" has "emerged" at some later point. If the latter is the case, however, then we need a theory to explain how something fundamentally new and nonreducible (or initially predictable) can ever have emerged. And if that happened once, why only then, and never again? Otherwise, all we would in principle ever need to know is the nature and structure of the initial moment and its operable causal laws—the so-called theory of everything—and all else would follow necessarily. That is equivalent to claiming that the theory of quantum gravity will not only be the comprehensive unifying theory of everything, but it will also, at least in principle, be exhaustive of all possible explanations. All other theories would only be short-hand expressions of the laws of quantum gravity.

To be still more precise: any concept from any more "developed" science (or religion, art, culture, etc.) would have to be capable of being completely describable and explainable (that is, completely replaceable without conceptual remainder) by concepts and laws drawn solely from the theories of quantum gravity. Thus, qualities such as thinking, faith, love, care, aspiration, marriage, money, inflation, depression, trust, and, of course, consciousness and freedom would have to be in principle completely describable in terms of quarks (or strings) and explained as quantum events. In fact, the entire world of qualities would have to be treated as ultimately illusory epiphenomena.

Consider, for example, two further problems with this deterministic paradigm. As Werner Heisenberg liked to point out, if you heat a magnet sufficiently—to about 720°—it loses its magnetic properties. When you let it cool again, it regains those properties, but there is *no way* to determine *in advance* which side will become positive, which negative. The result is a purely 50-50 random determination. Then there is the point made clearly by Heinz Pagels to the effect that the Second Law of Thermodynamics—the law of entropy—holds only for systems, and can say nothing about, and is not reducible to, the behavior of individual molecules. How can we explain either of these processes in a deterministic fashion and without referring to anything other than the laws governing quark soup and the big bang?

Reconstructing Scientific Logic

Let us look further into the problems posed by this *metaphysical logic* that secretly undergirds reductionism. It expresses what might well be called a linear causal deductivism. That means that it seeks to explain events by looking for the causal factors that not only roduce but can also completely explain the "emerging" properties and powers in a step-by-step process without remainder. It understands those factors not only as the elements whose combination is completely responsible for the resultant events and structures but also as elements capable of completely explaining all of its properties and causal powers—thus providing the necessary and sufficient conditions for a complete explanation. Its research program implicitly assumes that to explain an event or structure is to reduce it to the logic of operation of its constituent elements. In principle, then, this resultant event or structure is *nothing but* the result of the activity of those causal elements, and its behavior can be completely explained by the laws that govern its constituent elements. Hence is reproduced the Cartesian program that framed the seventeenth century's Scientific Revolution by seeking to analyze complexes into simples, and then rationally (and mathematically) to reconstruct the initial complexes out of those simples.[18] In an important sense, however, this is "nothing but" the mathematization of the Aristotelian deductive logic that has provided the foundation for scientific inquiry since the fourth century B.C.E., of which more will be explained later.[19]

But why should we assume the adequacy of the Cartesian reduction—or Aristotelian deductive logic, for that matter? We have already seen that the logical conclusion of this process is the implicit claim that all was included and implicitly deducible from the initial conditions of the "big bang." Thus, our problem with this logic is not solely the problem of adequately addressing the so-called mind-body problem—explaining the nature of consciousness and purposeful behavior in a deterministic physical world. It is in fact a more generic problem of explaining the *relative* autonomy of numerous realms of being from the most “primitive” to the most complex. Let’s consider several examples where reductionism fails, and an alternative metaphysical logic is suggested.

We have already had occasion to refer to the Second Law of Thermodynamics and to Heisenberg’s Uncertainty Principle, to both of which we need now to devote more attention. But let us first briefly consider some other problems with the prevalent model:

1. Consider the stabilization of the Earth’s climate. The Sun provides 99.98 percent of the Earth’s energy in the form of electromagnetic radiation, much of it in the visible range. The Earth is warmed by the approximately 70 percent of that energy that is absorbed—the remainder being reflected away by the Earth’s atmosphere before absorption. After absorption, that energy is reradiated in the form of infrared heat, which itself tends to be trapped by the atmosphere until the Earth heats up sufficiently to increase the heat differential between the Earth and its surrounding space so that the heat is finally able to completely escape as infrared radiant energy. Ultimately, heat-in equals heat-out, and the Earth’s climate reaches an equilibrium balanced at a specifiable temperature. The same is true of course for Mars, Venus, and the other planets—as well as for most hot bodies.

One can rather precisely calculate the amount of energy coming to the Earth, and the amount leaving, and in principle trace the precise paths that energy takes in warming the planet and producing the so-called greenhouse effect. Further, that energy is a necessary condition for almost everything that happens on this planet—certainly for the development of life in its indefinite variety of forms. Practically nothing that happens on Earth can fail to be influenced by this energy cycle—and nothing can impede the laws of operation that determine that heat-out will equal heat-in at any specified temperature. But does this natural process *determine* what takes place on the Earth? Would it make *any* sense to treat this process in a reductionist mode? Of course not. The energy transfer provides a “boundary condition,” it sets limits on the amount of energy available, and in what form. But it does not determine what is done with that energy, the quality, extent, nature, or direction of that activity. Rather, one might say that that resultant activity is an emergent property of the energy-transfer system. That system provides the necessary, but hardly the sufficient or determining, quantitative conditions of distinctive qualitative energetic activity on our planet.

2. Similarly with gravity. Gravity concerns itself solely with the issues of mass-energy and distance. Its effects can be calculated quite precisely, and are oblivious to any and all qualitative modifications of mass-energy. Considerations of quality, structure, internal processes, and values are irrelevant to calculations of gravitational forces, and can have no effect on them. But can gravity be said to determine them? Can gravitational laws predict what properties they will have? Or how they will behave? Of course not. What they can do—and with great precision and without exception—is set precise quantitative limits on that activity. As with climate and heat, gravity’s causal relation is structural, being at the same time constraining and empowering. It channels activity without determining it. And thus offers a vital lesson in the appreciation of the relation of natural processes to emergent properties.

3. One way to think of this is in terms of “conservation laws.” Rather than determining in a deductive causal manner the consequent reality, scientific forces are better understood as specifications of what cannot happen—of forces that must be conserved throughout all transactions, and thus provide inescapable quantitative limits and structural conditions

that constrain and empower the processes that emerge. Clear examples of such fundamental conservation laws are those that govern mass-energy, position-velocity, electric charge, and atomic spin. These cannot be violated. But they are not determining. They provide, as it were, necessary, but not sufficient, conditions for explaining a particular event. They lead one to think of reality as composed of an indefinite number of structural levels, each of which contributes to, but limits, the nature and scope of the activity that can be built upon it at "higher" levels. This offers us a precious clue to an ontological model of reality upon which we will build in the discussion that follows.

4. Consider, for example, the operation of evolution. Clearly, acquired characteristics are not inherited. The vehicle of hereditary transmission is the genome, the carrier of the DNA. It is the transmission of the DNA from one generation to the next that determines the genetic endowment of the offspring, determining some traits directly, and providing an indefinite range of possible capacities for many others. But the mechanism that determines the survivability of the resultant organism is natural selection, which functions primarily at the level of the phenotype, not the genotype. The relevant questions here are the adaptability of the resulting organism *in the particular environment* within which it finds itself. The point being that while the phenotype may be in whole or in part determined by the genotype, natural selection, itself a property of the environmental field, will ultimately decide which organisms and species—hence DNA sequences—survive or not. Thus, the long-term future of the genome will be decided by the wider field in which it operates but to which it is a relatively minor contributor. Hence, the causality of evolution cannot be explained by, or simply reduced to, the operation of the constituent elements that play such a vital causal role in determination of the inherited characteristics of individuals and species. Evolution must be understood as a process of transactional fields.

The Challenge of Entropy

A remarkable thing about the Second Law of Thermodynamics is that it cannot be deduced from any other law. It is a generalization from experience that is apparently universal in scope, and yet completely independent of any other natural law. Yet it ranks as one of the most fundamental theories of contemporary natural science, and poses basic challenges to a reductionist perspective.

There are many ways to state the law. When Sadi Carnot first formulated the law in the middle of the nineteenth century, he was concerned with the impossibility of converting all of the energy generated by a steam engine into useful work. Some energy was always lost. Thus, while the First Law states that the amount of energy in a closed system remains constant—the law of the conservation of energy, since revised in accord with relativity as the conservation of mass-energy—the amount of energy available to do useful work is continually being reduced.

Why is this, one might ask. Why does heat not flow spontaneously from a colder to a hotter body? Why do organized systems tend inevitably over time to become less organized—unless, that is, they receive energy inputs from without? It's like what happens to your house unless someone comes along regularly to clean it up. It seems that organized systems are ones whose internal organization is highly improbable, and thus can be brought about—and maintained—by doing work, which requires a continual infusion of energy. Without the necessary input of energy, the work cannot be done and the system tends on its own to move from a less probable (and more organized) to a more probable (and less organized) state. The key being that organization requires work, which takes energy, and that energy cannot be converted into work with 100-percent efficiency. Some of its capacity to do useful work is inevitably degraded.

It is this property of closed systems to move from states of lesser probability (and order) to those of greater probability (and relative disorder) that is the meaning of entropy. Thus, the Second Law can be formulated to say that the entropy of closed systems is continually increasing. (In so far as the universe is a closed system, its entropy should also be increasing, as it moves toward an equilibrium condition [of maximum probability and minimal order] in which there is no more available energy to do useful work. How gravity may effect this process, and whether there are unknown capacities available for the initial creation of sources of energy—which might be suspected in view of the original "creation" of this universe, not to speak of the "discovery" of "dark matter" and "dark energy"—remains to be determined.) Thus, the statement that the entropy of a closed system is continually increasing is equivalent to the statement that the disorder of the system is increasing. In short, "entropy is probability in disguise."[20] Living systems, on the other hand, are states of dynamic equilibrium that constitute islands of high order and low entropy surrounded by realms of increasing entropic disorder and dissipation. Of course, their existence does not in any way conflict with the operations of entropy, since living systems are essentially energy-transfer units open to, and drawing subsistence from, their environs. Thus, their survival is ultimately bought with useable energy extracted from those environs, often with quite deleterious effects on those environs.

In sum, as Silver notes: "No one has yet succeeded in deriving the second law from any other law of nature. It stands on its own feet. *It is the only law in our everyday world that gives a direction to time.*" "The laws of motion and Maxwell's laws are unchanged by reversing time. Any process described by these laws can be run backwards without violating the laws."[21] The same is true for relativity and quantum mechanics. Entropy is time-irreversible, and cannot be derived from the other fundamental laws that are in principle time-reversible. Newton's laws of motion, for example, are completely obeyed by the behavior of gas molecules, but they would be as well obeyed if the process ran backwards. Only probability seems to dictate that it can't happen.[22] The mechanical laws are being obeyed with respect to the behavior of each individual molecule, but they cannot alone predict the behavior of the collection. Thus, Silver concludes, "*there is no law based on the behavior of individual molecules that indicates that mixed gases cannot spontaneously unmix.* And yet there seems to be a natural direction for spontaneous processes. . . . *the direction of spontaneous, irreversible processes is always the same as that in which we think that 'time' develops.*"[23]

Thus, "we can dispense with physical laws of cause and effect, such as the laws of motion. . . . the direction of spontaneous processes is determined by probability, and . . . the direction of time is tied to the direction of increasing probability. . . . (But) *probability in itself gives no preferred direction for a system to evolve.*"

The implications of the Second Law are, of course, enormous, but here I wish only to highlight one. We seem to be confronted at the very center of modern physics with an emergent system, a structurally distinct level of being—with its own laws and causal properties—whose governing laws cannot be reduced to, or deduced from, those that govern the behavior of its constituent elements. This structurally distinct level of being—with its emergent properties, not the least of which seems to be the irreversibility of time, at least at macrolevels—constitutes one of the most fundamental contours of the real world.

Quantum Uncertainty

From a classical point of view, there are several things wrong with quantum theory. Predictions are always statistical, and never for individuals; there seems to be a fundamental indeterminacy in the behavior of ultimate entities; ultimate reality seems to be both wave and particle—it acts like a wave but reveals itself only as a particle; it is fundamentally impossible to separate the observer from the observed; and some of the ultimate particles (quarks, possibly strings) seem to be completely unobservable and only to function in structured relations, never alone, while each type of ultimate particle (also including electrons and neutrinos) seems completely identical to other members of the same group,[24] without any singular properties that alone can explain the forces between them and the structures (of the universe) to which they ultimately give rise. In short, the project of classical metaphysics seems to have come up against a dead-end with quantum theory—however much it may continue knocking its head against the wall of larger and larger accelerators in its search for the ultimate constituents of reality.

"In classical physics," observes David Lindley, "we are accustomed to thinking of physical properties as having definite values, which we can try to apprehend by measurement. But in quantum physics, it is only the process of measurement that yields any definite number for a physical quantity, and the nature of quantum measurements is such that it is no longer possible to think of the underlying physical property (magnetic orientation of atoms, for example) as having any definite or reliable reality before the measurement takes place."[25]

Even more problematic than the famous collapse of the wave function, the problem of measurement, wave-particle duality, the essentially probabilistic and nonpredictable behavior of individual subatomic particles, and the fundamental equivalence of matter and energy is the problem of nonlocal causality. Nonlocality—which Einstein could never accept, but which now seems to have been experimentally confirmed—has been described as "one of the most surprising and paradoxical aspects of quantum theory in that parts of a quantum system that have been connected in the past retain an instantaneous connection even when very far apart."[26] It suggests that "two parts of the same system separated in space are linked by a quantum field."[27]

An Emerging Alternative

It is instructive to recall that the Scientific Revolution practically begins with an attack by both Descartes and Bacon on the Aristotelian notion of final causality. To explain something in terms of its final cause was to seek to explain its nature and behavior by reference to its "telos" or purpose, the reason for its existence. The emerging mechanical science of the seventeenth century is resolutely antiteleological. The behavior of things was to be explained solely by reference to their "efficient cause," those mechanisms or structures that "caused" them to behave as they do. There was no place in such descriptions or explanations for appeal to any final cause or purpose. It was precisely this approach that provided the philosophical foundation for the determinism of the emerging mechanistic science.

But this research strategy is a perfect expression of the purposeful structure of intentional thought. The logic of scientific inquiry that gave birth to a reductionist system of mechanistic determinism was itself a perfect expression of precisely that purposeful logic whose reality it was denying. As we investigate and seek to reduce mental to brain processes, we must demonstrate how physical processes can acquire those intentional capacities that are one of the most astounding characteristics and powers that mark the emergence of the mental. Nothing, at least, would seem to be more clear than that these two systems—the physical and the mental—operate in accord with distinct and opposing logics.

We may draw a clue on the nature of emergent phenomena, however, from the examples of quantum mechanics and thermodynamics. In both cases, it is the *organizational structure* or field properties of the situation that determine its mode of operation and governing laws. They provide the explanatory framework and causal nexus that is required to make sense of the nonreducible properties of the resultant behavior. In speaking of the charge of the electron, Nobel Laureate Robert Laughlin writes:

> We are accustomed to thinking of this charge as a building block of nature requiring no collective context to make sense. The experiments in question, of course, refute this idea. They reveal that the electron charge makes sense only in a collective context, which may be provided either by the empty vacuum of space, which modifies this charge the same way it modifies atomic wavelengths, or by some matter that preempts the vacuum's effects. Moreover, the preemptive ability of matter requires the organizational principles at work there to be the same as those at work in the vacuum, since otherwise the effects would be miracles.[28]
>
> The electron charge conundrum, as it turns out, is not unique. All the fundamental constants require an environmental context to make sense.[29]

This relational causality contrasts with the reductionist logic that would claim to explain the behavior of all complex systems solely by the causal properties and governing laws of its constituent elements. But what has given such initial plausibility and pervasive theoretical hold on our imagination to that reductionist paradigm? I think it is the conceptual structure classically articulated first in Aristotle's deductive logic and corresponding metaphysics, to which reference has already been made.[30]

Central to the Aristotelian analysis of rational thought is the notion of the syllogism. It has long been known that nothing objectively new can emerge out of a syllogistic argument. It is precisely the fact that the conclusion can never contain more content than is at least implicitly included in the premises that provides the syllogism with its demonstrative certainty. (This does not, of course, deny that the deductive conclusions may provide useful and informative claims that are psychologically new, but one must not confuse the order of thinking with the order of being and truth.) Syllogistic reasoning may set a standard for the structure of valid arguments, but it leaves much to be desired when it comes to creativity, imagination, and novelty. It provides a means of demonstrating the truth of a position on the basis of initial positions already agreed to, but it provides little assistance in the search for the new.

It should be obvious, therefore, that to the extent that the syllogism provides the model of rational thought, such thought must always find nonreductive theories intrinsically inadequate.[31] It is a box from which we can never exit. But on what basis can we be so sure that the world is structured along such deductive "syllogistic" lines, and that Aristotelian metaphysics reveals the structure of being. If quantum theory had done nothing else, it has provided a fundamental challenge to this reductive mode of analyzing individual behaviors, to which Symbolic Logic has added the irreducibility of relations to their constituents.

Certainly creativity and scientific innovation cannot be generated or explained by syllogistic paradigms. That was, no doubt, the point Einstein had in mind when he referred to scientific theories as "free creations of the human mind,"[32] a point to which numerous theorists have been sensitive even if they have often failed to draw this more important metaphysical conclusion.[33]

Some Additional Emergent Properties

Consider a brief exchange between two people. (The example is Bhaskar's.) Person A tells person B to give thing C to person D. B follows suit. Clearly this behavior was "caused" by the communication. Something "really" happened, that would not have happened had it not been for the verbal communication. That communication was "intentional" and "purposeful," and it had an effect in the real world. It makes no obvious sense to suggest that the physical movement of the sound waves alone could have had that causal effect.

In fact, that intentional behavior could not have taken place had there not already existed an operative language that was shared by both A and B. The private and individualized intentions of both A and B presupposed the prior existence of a socially shared set of meanings that permitted them to form those intentions, and then articulate them in a language that each could understand.

Now, we may well suppose that A, B, and D are physical systems with physical properties that can be well and accurately described in the terms of physics, chemistry, biology, physiology, neural physiology, and brain chemistry. I am quite willing to suppose, in accord with the best of current science, that there is "nothing more" than such physical systems at work constituting A, B, and D. But can one then suppose that these systems can *on their own terms* adequately account for the behavior in question. Where comes the intentionality of the individuals in question? And where comes the linguistic meanings that the individuals presuppose? In short, the meaningful behavior of the individuals presupposes a relatively autonomous social realm, while the intention to communicate presupposes a relatively autonomous individual realm, none reducible to the other.[34] Our challenge is to make sense of these relatively autonomous realms as emergent properties of natural systems—subject to, but not determined by, the original conditions set down by the big bang.

In this last example, we have suggested the existence of at least three distinct and nonreducible causal structures: the psychological-individual, the sociological-linguistic, and the neurophysiological and biochemical. The first is in general the realm of consciousness; the second, the realm of mind and meanings; and the last, the realm of natural processes, including living things, which, no doubt, deserve their own realm, of which more will be explained later.

The Nature of Emergence

In the foregoing discussion, I suggested problems intrinsic to the reductionist paradigm, and offered several examples of areas in which it seemed to fail. I want now to attempt to elucidate more precisely what I mean by emergence, and to provide criteria for the determination of emergent structures and phenomena.[35]

Emergent phenomena are ones whose nature and operation cannot be completely explained by a description of the behavior of their constituent parts. They are systems of structured networks of relationships that have properties quite different from those of their "constituent elements." This means that the emergent has properties, powers, and modes of operation[36] that: (a) are not possessed by the elements that make it up and (b) cannot be completely explained by, or reduced to, the properties and causal powers of those elements alone. Rather the properties and causal powers of the emergent are systemic. They are properties of the structure of the system. They operate in accordance with a causal logic that is particular to the emergent structures, and that requires the use of concepts and principles that cannot be completely replaced by those that describe the behavior of its constituent elements. Furthermore, the emergent's systemic properties and causal powers will usually have consequences that can actually determine the behavior of the very elements that compose it.[37]

To think of this in very specific terms, consider an effort to provide a reductive explanation of a purportedly emergent phenomenon. It would have to use only terms and theories that were drawn from the levels of explanation that were appropriate to the constituent elements. The only new terms it could use would be ones that served as shorthand expressions for complex processes that were "nothing but" the logical and/or causal consequence of the activity of the elements. It could not create new terms for properties or causal powers that were not directly applicable to—or explainable in terms of—its original domain. An example of a completely adequate theoretical reduction would seem to be that which explains heat as "nothing but" the expression of the average speed of the motion of the associated molecules. "Heat" is generally claimed to be only a shorthand expression for the impact of that average molecular motion.[38]

In a preliminary discussion of explanatory reductions, Searle distinguishes between eliminative and noneliminative reductions.[39] An eliminative reduction is one like that which explains (and thus explains away the apparently autonomous reality of) sunsets, which are simply the result of our stationary location on an Earth that is rotating on its axis as it revolves around the Sun. On the other hand, a noneliminative reduction is one that causally explains the real emergence of a new property. Such an emergent property is explained by the behavior of its lower level elements—but it is not itself a property of those lower level elements, for example, solidity or liquidity, the atoms of which are neither solid nor liquid, or color as the expression of distinct frequencies of light that are not themselves colorful. But the question here is, are the higher-level qualities and behaviors completely explainable in terms of the structure of the constituent elements? Or do we have to smuggle in the concepts of solidity and liquidity into that underlying level in order to carry out the explanatory reduction?[40]

Of course, the discussion of the reality of emergence is not meant to deny the dependence of emergent phenomena on the processes out of which they emerge. Quite the contrary. It would be appropriate, at least at first, to think of this as a process of layering, in which emergents build up and are constrained by the powers of the underlying structures. In fact, emergent phenomena are best thought of as themselves elements of emergent structures that express the unique organizational properties and powers of distinctive fields or levels of reality. When one speaks of these powers as being systemic, what is meant is that a structured field emerges with its own distinctive properties and causal powers. This field emerges out of the elements that, in constituting it, condition both its appearance and its mode of operation, providing both enabling conditions and operative limitations. The emergent cannot violate the laws that govern the underlying field, but those laws are not sufficient to explain or initially predict the behavior of the emergent field. Thus, gravity conditions life, and no life can violate gravitational laws, but gravity does not determine what living things do. "For a *diachronic* (that is, temporally causal) *explanatory reduction*, in which the processes of the formation of the higher-order entities are reconstructed and explained in terms of the principles governing the elements out of which they are formed, is compatible with *synchronic* (that is, contemporaneous) *emergence*, in which the higher-order principles cannot be completely explained in terms of the lower-order ones. Note that it is to the former that biologists are committed in investigating the origins of life (or engineers in constructing machines), but it is to the denial of the latter that the materialist is committed."[41]

Language, for example, requires brain cells to transmit electrical signals, but none of those cells have or understand language. Their behavior operates in accord with the causal structures of neurological networks, but when involved in language activity, their behavior follows the patterns dictated by the embedded meanings, none of which can be at odds with those neurological structures, but the meaning patterns of which can only be adequately explained by drawing upon the mental structure of meanings—including the syntactic and semantic structure of language, and the socially rooted psychic intentions of the language user. Hence, a scientifically adequate causal account will have to incorporate explicit consideration of the structured field of objective meanings embedded in the culture as well as the unique personal concerns of the individual.[42]

An emergent property or structure thus functions primarily in accordance with its own logic of operations. It requires a specification of the structural boundaries that determine what is and what is not within the domain in question. The emergent field operates in accordance with a causal logic that is to some extent *sui generis*. It determines and partially explains the behavior of *its* constituents, but only on its own terms—even though it will undoubtedly and of necessity draw upon the causal powers of the underlying fields.

Emergent properties are nowhere more evident than in the phase transformations that naturally abound in daily living. In phase transformations, the underlying atoms undergo a structural transformation in the chemical bonds that gives rise to complex substances with distinct properties and modes of operation that are not characteristics of the underlying material. Nothing is more pervasive than the regular transformations of water occasioned by changes in temperature (and/or pressure) from ice to steam, or even plasma. These transformations occur at specific conjunctures of temperature and pressure that occasion the organizational restructuring of the same chemical molecule, thus realizing different properties and modes of interaction. Another graphic example is that provided by graphite and diamond. The former is one of the softest materials known, used as a lubricant and as the writing element in pencils, while the latter is one of the hardest materials known, yet both are composed of the same element, carbon, in which only the structure of the chemical bonds is different. Clearly, then, the resultant emergent properties are not properties of the isolated carbon atom, but of the structural organization of that element into these distinct substances.[43]

In most all of these cases, the (diachronic) causal conditions that lead to the phase transformation can be spelled out with great precision, but the resultant (synchronic emergent) properties are not logically deducible from the properties of the constituents, but are systemic properties of the emergent substance, subject only to the boundary conditions or conservation laws for the constituent elements.

Laughlin makes this point quite nicely:

> The phases of matter—among them the familiar liquid, vapor, and solid—are organizational phenomena. Many people are surprised to learn this, since phases seem so basic and familiar, but it is quite true. Trusting the ice [when skating] is less like buying gold than buying stock in an insurance company. If the organizational structure of the company were to fail for some reason, one's investment would vanish, for there is no physical asset underneath. Similarly, if the organization of a crystalline solid—the orderly arrangement of the atoms into a lattice—were to fail, the rigidity would vanish, since there is no physical asset underneath it either. The property we value in either case is the order. Most of us would prefer not to think we are entrusting our lives to an organization, but we do it every day. Without economies, for example, which are purely organizational phenomena, civilization would collapse and all of us would starve.[44]

A Metaphysical Caveat

I have been arguing for the existence of completely emergent fields that are logically irreducible to their constituents. It is important to note, however, that there would also seem to be many situations for which field theories would be the most appropriate tools to describe a reality that *is* in principle reducible to the operation of its constituent parts, though in practical fact too complex to be so described. Examples of the latter might include anything from aspects of the reduction of chemistry to physics, to strategies for playing chess. For example, Steven Weinberg has written that:

> after the development of quantum mechanics in the mid-1920s, when it became possible to calculate for the first time . . . the spectrum of the hydrogen atom and the binding energy of hydrogen, many physicists immediately concluded that all of chemistry is explainable by quantum mechanics and the principle of electrostatic attraction between electrons and atomic nuclei. . . . Experience has borne this out; we can now deduce the properties of fairly complicated molecules—not molecules as complicated as proteins or DNA. . . . But chemical phenomena will never be entirely explained in this way, and so chemistry persists as a separate discipline.[45]

To which, however, we might well counterpose the previous quotation (and extensive endnote) from Laughlin on the irreducibly structural nature of these levels of reality. The resolution of this issue is unclear to me.

An extremely interesting example of this "metaphysical caveat" is the so-called cellular automaton phenomenon, in which the logical behavior of the elements can be spelled out in complete detail, but the resulting behavior of the complex system expresses "emergent" properties that can neither be predicted nor anticipated.[46] Thus, the behavior of such systems would seem to be logically predictable in principle, not revealing any relational properties that are themselves emergent, and yet in practice completely unpredictable on its own terms and in need of a distinct field-theoretic interpretation.[47]

Only empirical inquiry joined to careful philosophical attention to the logical status of the employed concepts can determine the truth of a particular theory, and hence the appropriateness of a particular approach—whether structural and field-theoretic or not—in each specific field of inquiry. Our primary argument is to the effect that there seem to exist quite important nonreducible relational fields that require a distinct field-theoretic metaphysic for their interpretation. But such field-theoretic frameworks would also seem to be called for by the internal complexity of many areas, such as gliders, that are not themselves logically emergent. Each of these two types of systems would require in practice the application of an ecological vision and field-theoretic framework, although they would ultimately pursue different fundamental logics, thus pointing toward distinct research agendas and explanatory frameworks, and bearing quite distinct metaphysical and ethical import.

The Metaphysics of Historicized Fields

If there is something fundamentally wrong with the "classical" substantive metaphysics, what then is/are the alternative(s)?[48] It would be presumptuous to claim that there can only be one alternative. Certainly I have no intention of trying to offer a "transcendental deduction" of any suchtruth. My intent is only to present a theoretical framework that seems to be suggested by, and to make coherent sense of, the converging results of modern theory and practice. First, I wish to set forth that alternative metaphysical frame. Then, I will suggest how by reposing fundamental conceptions of theory and practice, it may offer a more constructive way to address pervasive concerns of the contemporary world.

I can begin with the aforementioned Einsteinian identification of matter and energy, as spelled out in that most famous equation, $e=mc^2$. If matter and energy are equivalent, then clearly from the perspective of relativity, either can be expressed as a function of the other. Energy can be understood as matter "unleashed"; or matter as energy "congealed." But neither is "basic" or fundamental—or both are!![49] Thus, it would be as appropriate to see the world as "made up" of patterned energy as of structured "things." In the words of Nobel Laureate Leon Lederman, "The physical world is a fabric of events."[50]

"It was Einstein who radically changed the *way* people thought about nature," continues Lederman, "moving away from the mechanical viewpoint of the nineteenth century toward the elegant contemplation of the underlying symmetry principles of the laws of physics in the twentieth century."[51] Consider Einstein's own statement of the problem:

> Matter represents vast stores of energy and . . . energy represents matter. We cannot, in this way, distinguish qualitatively between matter and field, since the distinction between mass and energy is not a qualitative one. By far the greatest part of energy is concentrated in matter; but the field surrounding the particle also represents energy, though in an incomparably smaller quantity. We could therefore say: matter is where the concentration of energy is great, field where the concentration of energy is small. . . . There is no sense in regarding matter and field as two qualities quite different from each other. We cannot imagine a definite surface separating distinctly field and matter.
>
> The same difficulty arises for the charge and its field. It seems impossible to give an obvious qualitative criterion for distinguishing between matter and field or charge and field. . . . [Thus] we cannot build physics on the basis of the matter concept alone. . . . Could we not reject the concept of matter and build pure field physics? What impresses our senses as matter is really great concentration of energy into a comparatively small space. We could regard matter as the regions in space where the field is extremely strong. In this way a new philosophical background could be created. Its final aim would be the explanation of all events in nature by structure laws valid always and everywhere. . . . There would be no place, in our new physics, for both field and matter, field being the only reality. This new view is suggested by the great achievements of field physics, by our success in expressing the laws of electricity, magnetism, gravitation in the form of structure laws, and finally by the equivalence of mass and energy.[52]

But this is still not the quantum world. In fact, contemporary physics speaks sometimes of fundamental particles, sometimes of basic energy packets, and sometimes of waves and frequencies of energy. It even speaks of the basic reality of possibility, as, for example, of the possibility of finding a particle at a specific location or with a specific velocity. But, note, not of finding both the precise velocity and location of the same "particle" at the same time, due to the Uncertainty Principle. That Uncertainty Principle itself is open to many interpretations, not unrelated to the fact that the reality being tested for seems to have properties that approximate waves of probability in which velocity and location are two of many pairs of complimentary properties. This also suggests the possibility of seeing The Real as patterned waves of energy, described in terms of frequencies and amplitudes. But then the greater and more frequent the amplitude—and consequently, the more discrete the appearance of its energy packet—the more its appearance approximates a discrete object or atomic thing.[53]

I will return to these considerations and their significance later. At present, my concern is simply to use them as a jumping-off point that not only underscores the inappropriateness of the traditional metaphysics but also begins to suggest an alternative.[54] What a focus on the fundamental nature of energy makes clearer than does the exclusive focus on matter is the need to step back from an excessive concentration on the individual entity in order to grasp the dynamic pattern that is being displayed. It is fairly clear with respect to energy that it expresses itself *temporally* as well as spatially, and that it is not *static*. It changes regularly in space and time. In fact, for Einstein, the relativity equations require appeal to a “fourth dimension,” that of space-time, thus underscoring their essential unity. But as soon as one takes time as fundamental too—as Newton and classical physics did not—then the dynamic pattern of change (even perhaps of the basic “laws” and “forces” themselves) comes to the fore.

An energy pattern is spread out over space and time. It is not a point particle, nor does it exist at a single location. It would be as true to say that the things that appear are as much a result of the pattern of forces as that the forces are an expression of the action of the things. In fact, there seems to be no need to reduce one to the other. The equivalence of matter and energy is just another way of expressing the essential unity of matter-energy as of space-time. We might thus begin to reconceptualize the reality of matter-energy as a dynamic force field. By field we understand a dynamically structured temporally unfolding pattern of activity and events.[55] As we will see, such fields can be causally and empirically layered, with qualities being primarily determined by the space-time field, only secondarily attributable to the things that emerge themselves as field qualities. Thus, fields themselves have emergent laws that describe their mode of operation, distinct from, and nonreducible to, the qualities and laws of their generative “parts.”[56]

> Since principles of organization—or, more precisely, their consequences—can be laws, these can themselves organize into new laws, and these into still newer laws, and so on. The laws of electron motion beget the laws of thermodynamics and chemistry, which beget the laws of crystallization, which beget the laws of rigidity and plasticity, which beget the laws of engineering. The natural world is thus an interdependent hierarchy of descent.[57]

Another way of expressing these ideas is to say that we are dealing with a world of patterned and layered fields of matter-energy in space-time. These may be conceptually reconfigured by perspectival intentional interventions, that is, as seen from different perspectives and in accord with diverse intentions. In such cases, the more concentrated the field, the more distinctly individualized its “elements” will appear—taking the form of things—and the more distinct the being and action of one “field” is from that of another; the less concentrated (or more dissipated or diffuse) the field, the more it merges with neighboring fields, or things.[58]

By perspectival intentional interventions, I mean to highlight the integral relation between the perspective or space-time location of the thinking subject and the meaningful structure of the intended objective field being described. This must not, however, be taken to suggest either that the subject simply constitutes the meaning of the object or that “everything is relative to the ‘observer.’” Rather it should be taken at least in part as a restatement of Einstein’s discussion of “frames of reference,” the import of which is that, while the values of variables such as position in space and time may be different for different observers, the fundamental laws of nature are invariant between frames of reference. But the frame of reference must be self-reflectively included in the description of the situation in question. Of this, and its relation to metaphysics and social theory, more will be explained later.

These thoughts are just initial suggestions or outlines of the plausibility of an alternative metaphysical paradigm. That paradigm means to suggest that we should no longer view The Real as essentially “thingafied,” as a coordination of objectified nouns engaging in “verbal” interactions. Rather, we have to replace the metaphysics of “things and persons" with one of the dynamically structured patterns of matter-energy in space-time.

To get an initial sense of the significance of this change, consider traditional Indo-European languages. What would be the metaphysically appropriate alternative to "'it' is raining?" John Dewey had once suggested replacing nouns with verbs and adverbs in order to express the processive nature of reality, but clearly that will not do. It is not a question of reducing things to activities, however much that does assist in breaking the conceptual (and perceptual) stranglehold of the substantive metaphysics. We need to appreciate the experienced reality of space-time that William James captured with his famous description of the experience of "thunder-crashing-in-on-silence-and-contrasting-with-it." James understood that our traditional conceptualizations made nonsense of this lived experience—however inadequate his own first "pragmatic," and then "radical empiricist," efforts at reconceptualization.[59]

It is not for an activity to replace an object or event, but for a "patterned whole" to be constituted by the active emergent field elements. It is, of course, essential, however, to see that the logic of the operations of that "whole" includes, as well as is expressed and is transformed by, the existence and activity of those "things" that are intrinsic to its existence. "The world," comments Heisenberg, "appears as a complicated tissue of events, in which connections of different kinds alternate or overlap or combine and thereby determine the texture of the whole."[60]

> "What are these corpuscles really?" Schrodinger answers ". . . at the most, it may be permissible to think of them as more or less temporary entities within the wave field, whose form [Gestalt], though, and structural manifold in the widest sense, ever repeating themselves in the same manner, are so clearly and sharply determined by the wave laws that many processes take place as if those temporary entities were substantial permanent beings."[61]

Harris develops this point:

> What is here making itself felt is the effect of the transition from classical to quantum conceptions. The abandonment of the notion of hard, point-like, particulate constituents of matter is forced upon us by the quantum approach, and many eminent scientists have expressed the view that the explanation of physical phenomena is not to be reached by analysis of them into separable, additive entities, events and forces, but only through the recognition and study of structured totalities, which are neither simple unities nor dissectible aggregates, but are diversified wholes of distinguishable though inseparable constituents. Max Planck writes: "Modern physics has taught us that the nature of any system cannot be discovered by dividing it into its component parts and studying each part by itself, since such a method often implies the loss of important properties of the system. We must keep our attention fixed on the whole and on the inter-connection between the parts."[62]
>
> Lindley elaborates:
>
> In classical physics, we are accustomed to thinking of physical properties as having definite values, which we can try to apprehend by measurement. But in quantum physics, it is only the process of measurement that yields any definite number for a physical quantity, and the nature of quantum measurements is such

> that it is no longer possible to think of the underlying physical property (magnetic orientation of atoms, for example) as having any definite or reliable reality before the measurement takes place.[63]

He further comments that in view of the Stern-Gerlach experiment, it would seem that the property of spin cannot simply be an intrinsic property of the point particle electron but somehow a property of its interaction with the electromagnetic field.[64]

> In other words, to reinforce the point we already made, an electron by itself is not described by one unique wave function; the way you describe it, the wave function you use, depends on what you plan to measure. And although the wave function obviously depends on the state of the electron, and on what you know about it, it can be misleading to think that the wave function somehow "is" the electron. It's better to say that a wave function describes a system—the thing being measured and the measurement being made—rather than being an independent description only of the thing being measured.[65]

In sum, in the words of Professor Stephen Pollack, "Every particle in nature can be thought of as a ripple in a field."[66]

Further, that field or "whole" is not itself completely set off from its surrounding fields. Here is one place where the importance of the above-mentioned notion of "intentional interventions" comes into play—and this *is* precisely the deeper truth being reached for by James' "pragmatism" and Dewey's "instrumentalism." For every field is itself a "whole" that is but a thing-like emergent from the more encompassing field of which it is a "part." In a deep sense, ultimately there is only one field, and that is the entire universe. That is the point of discussions of the gravitational attraction among planets and galaxies, and of the significance of questions about the expansion, stability, or contraction of the universe. But different "forces" have different effective ranges, qualities, and logics. And that refers also to the structure and properties of the field of which they are the forces. Such was the import of our prior discussion of the distinct but related questions of the perspectival nature of intentional interventions and of the objectively layered structures of forces and processes. It is precisely that analysis that provides the framework for an approach to the problem of freedom.

Freedom

The establishment of the semiautonomous reality of emergent structures provides the framework for a solution to the so-far intractable problem of the relation of freedom and determinism. To put it concisely, freedom is precisely such a nonreducible power of an emergent field constituted by complex, highly integrated energy exchanging self-maintaining or replenishing self-conscious life forms. It is thus subject to all of the deterministic causal forces that operate at the underlying levels, while drawing upon, and being empowered by, them in its own operation. But it is responsive to the imperatives of its own constitution, the experience of which is an objective and intrinsic property of the constituting field, and is neither reducible to the operation of its members nor explainable solely in terms of the behavior of its constituents. Thus, freedom is a property of the system, and not of any or all of its elements. It is realized by being it—and thus its reality is grounded in the *sui generis* experience of subjectivity. Let us now explain this more clearly and in greater detail, beginning with a definition of determinism, with which it is to be contrasted.

"A theory may be said to be deterministic if, using only the theory and a complete description of the state of the system, every subsequent state of the system is logically inevitable." Thus, "for every event there must be a cause, and so, given the conditions preceding the event, and the laws of nature, every event must be in principle predictable and in practice inevitable."[67] If freedom is to be anything other than a misleading illusion, it must involve the capacity of the organism to act in ways that are other than simple logical consequences of the preexisting conditions and operative natural laws. Hence, the free being must be able to initiate a causal chain that in principle is not simply the predictable causal consequence of the prior situation, and thus for which it is ultimately responsible.

It should be clear from this that freedom is the capacity of an organism to formulate by and for itself plans of action and to select from among them, and thus be responsible for what it does. It is thus clear how freedom is the foundation of moral responsibility and human dignity. What makes human freedom ontologically possible is the existence of self-consciousness, the capacity to treat oneself as an object of one's own reflection, placing oneself conceptually within the field of meaningful objects and possible activities. (We are not here addressing the issue of the relation of human freedom to the wider biological context of the capacities for self-determination of less complicated conscious living systems.)

No doubt, the possibility of the emergence of self-conscious beings is conditioned by the development of highly complex and internally networked biological systems. All the laws that govern such systems no doubt govern (and constrain the possibilities of) the activity of self-conscious beings. But self-consciousness is not a property of the elements of the living system of which it is composed, any more than information is contained in any one of the neurons that compose a neural network. Rather, in both cases, the emergent phenomena are field properties of the system. Consciousness is the subjective experience of a system with a sufficiently complex and adequately integrated biological network.[68] Such a system acquires properties and powers that its constituents do not themselves possess. In the words of Bennett and Hacker:

> What neuroscience can do is to explain, for normal human beings, how it is possible for them to be open to reason. But it cannot explain the rationale of human actions in the particular case, or elucidate what makes a certain reason a good reason. It can identify necessary conditions for the exercise of human capacities. But it does not follow that it is, or ever will be, in the position to specify a set of neural conditions that are sufficient conditions for characteristic human action in the circumstances of life. To explain typical human behaviour, one must operate at the higher, irreducible level of normal descriptions of human actions and their various forms of explanation and justification in terms of reasons and motives (as well as causes). These descriptions will cite multitudinous factors: past and prospective events that in given circumstances may constitute the agent's reasons for action; the agent's desires, intentions, goals and purposes; his tendencies, habits and customs; and the moral and social norms to which he conforms.[69]

Such emergent field properties of the constituent natural elements require no appeal to nonnatural elements. Thus, we can say, with Searle, "that brains cause minds," and "that minds are features of brains." (There is no reason in principle why such self-conscious natural beings could not be "artificially" created in the laboratory—or in any other appropriate venue—once sufficient knowledge of the constituent elements has been acquired. But any being so "created" would then possess a comparable degree of self-conscious autonomy.) But Searle's definition of features leaves the issue ill-defined, because he fails to adequately address the issue of emergence—and thus, also, he remains incapable of adequately addressing the issue of freedom. Instead, his "biological naturalism" looks suspiciously like a sophisticated biological reductionism that encounters freedom as an embarrassing surd.[70]

If we take our emergent naturalism seriously, however, it is to be expected that for each and every activity of consciousness, there will be a corresponding activity of the brain. This no more justifies the claim that minds are "nothing but" brains than would the claim that life is nothing but the activity of atoms since living beings are not made up of anything but atoms. The point in each case is that the emergent system has properties and powers that determine a mode of operation that the elements themselves do not possess.[71] This resultant mode of operation has objective and distinctive effects in the real world that cause its constituent elements to behave differently. The logic of its operation produces objective laws that are distinctive to its field of being. Of course, intervention is always possible at the underlying levels, and such intervention, in effecting the constituent elements, will obviously affect the consequent operation of the field. Thus, life can be deranged by changes in types and levels of radiation, and consciousness can be similarly affected by hormonal changes. But to establish that such biological processes are necessary preconditions of the operation of conscious activity is not the same as equating or reducing one to the other.[72]

It is further to be noted that there is no reason to suppose that any specific mental event is correlated with any particular neuronal or brain event. It is perfectly conceivable that very different brain events in the same or different persons can be identified with the same mental event. "Not only is it the case," observes Bhaskar, "that the same social or psychological states can be realized in a number, probably infinite, of different ways, but (worse) the reverse, viz. multiple social or psychological correlates of psychological or physiological states, also seems to hold."[73]

This is quite similar to the conception among cognitive scientists of "multiple realizability." That notion holds that a computer program can be carried out by an indefinite number of physical systems, so long as they have certain minimal properties. But that means that there is no necessary causal relation between the physical system and the operation of the program. Rather the system provides the necessary conditions for the implementation of the program, but the program provides the "logic" that determines the "meaning" of its operations. This provides a good model for the relation of the brain to the mind.[74] The brain makes possible mental operations but does not determine their meaning. Their meaning is intrinsic to the system of language in use—the system that only "uses" the brain as the apparatus for implementation—as well as to the wider social, biological, and natural world by which its activity is constituted as a nodal point. Thus, analysis of the hardware would not explain the meaning of the operation.

The point here is that there is no one-to-one correlation between brain states and mental states. The same person may have the same idea at different times, or different people may have the same idea, or the same thought may be expressed by the same person in different languages. The logic of the thought and the biology of the system operate in accord with different logics. Most centrally for the issue at hand, conscious beings engage in purposeful behavior, operating in accord with principles and meanings to which their biology is deaf.[75] But that behavior can have profound effects on the very possibility of that biological system to survive—as our prior discussion of evolution made clear.

> Cognitive processes would seem to be differentiated from non-cognitive ones in that they are at least typically (but not necessarily) *conscious, referential* (that is about something), and *intentional.* . . . But . . . it cannot be said that brain processes are *about* anything, that they are meaningful, or that they are true or false, or that they are *of* or *for* something (as is the case of beliefs and desires respectively.)[76]

There are, of course, important disanalogies between computers and programs, brains and minds. Most crucial, of course, is the existence of consciousness and purpose. Those are properties of the particular "hardware" that brains seem to be. The argument for multiple realizability seeks only to show the distinction between program and machine implementation. The quality of the implementing machine will determine not only its capacities to carry out the program, but also its relation to that program and the wider environment within which it operates. At this point, we are beginning to address the systemic field and the logic of *its* operation.[77]

Self-consciousness is itself an emergent property of consciousness and minds, each of whose terms refer to distinctive and complexly interrelated field properties. But it is important now to be quite precise in our use of words. We must clearly distinguish minds from consciousness, and the latter from self-consciousness. Very briefly, consciousness refers to the remarkable capacity of numerous living systems not only to be sensitive and able to respond to external (and internal) stimuli, but also to maintain the experienced presence of, as well as integrate from several distinct sources, those stimuli through time. Thus, a quality of subjective awareness of an experienced field of objects and activities emerges. While subjectively experienced as essentially unified, with its own distinctive affective quality, this emergent field is perceived as a patterned and bounded series of colors and shapes, with more or less distinctive elements appearing within a sustaining background—as with the famous figure-ground relation so familiar in Gestalt Psychology.

By consciousness we thus refer to the capacity of some living systems not only to be sensitive to stimuli but also to be able to sustain the presence of such sensitivity through time, beyond the moment of stimulation. It is in the "internalization" of the stimuli wherein lies the emergence of consciousness beyond the simple capacity for response. Clearly, this is a process that allows for vast and subtle degrees of difference, which have emerged and developed over time.[78]

With this internalization, a field of awareness begins to emerge. Elements take on relations for the subject within its field of awareness that their initiating stimuli did not initially have among themselves, including relations between present stimuli and recalled echoes of previous stimuli. With the expanding range and complexity of the organism comes an increased range, complexity, and potential sophistication in the experience of consciousness. Furthermore, instead of responding directly to the initiating stimuli, the organism can respond to the elements of its awareness, reorganizing them in accordance with its organismic demands. Consciousness thus refers to this capacity of certain living systems to experience an "inner" world as well as an "outer" world, and to reorder that "inner" world in a manner different from that of the "outer" one. Thus, we encounter two distinct operative "logics," with the emerging "inner" one responding to demands initially dictated by the makeup of the experiencing subject. It is here that we begin to see the emergence of the ultimately profound gap between the object of experience and the experience of the object. Furthermore, there is no reason to assume that the order and weighting of the elements of the subject's awareness will be the same as those elements would appear to another who was viewing or recording, but not experiencing them—or even to the same subject who is experiencing the exact same sequence of external events on two or more different occasions.

Such consciousness is clearly distinct from, but would seem to be a necessary precondition of, the emergence of mind. By mind is meant the capacity of living beings to "make sense" of their experience. "Making sense," in the most rudimentary sense, involves one aspect of consciousness suggesting or being linked with another. Initially, it might have involved something as simple as the kind of quasi-automatic associations discussed by Hume, namely those connections of images generated by resemblance, (spatial or temporal) contiguity, or causality. Any kind of juxtapositions from one or several senses might have suggested connections, where one "image" suggested another. Meaning would seem to have emerged out of experienced linkages, becoming an independent reality to the extent to which the "mental" connections were not biologically fixed and determined. As one "idea" becomes "linked" first with one, then with several ideas, and then with increasingly complex networks of ideas, it gains "meaning," that is, the capacity to suggest, refer to, symbolize, implicate, stand in for, prepare for, predict, or "prime," and therefore increase the likelihood of ideation in the immediate future, et cetera.

Meaning, however, does not reside in the idea itself, but in the network of connections. It is a property of the system more than of its elements. The systemic field determines its range, scope, complexity, sophistication, functionality, and affective tonality. As the field becomes structured, so does the range and sophistication of its capacity to generate meanings. Language is precisely such a structured field of meanings that determines the capacity of the participating consciousness to entertain and relate meaningfully to itself and its environment. Thus, while there can be no meanings without conscious beings for whom meaning exists—those, for example, who are the "bearers" of the language—the structure of the language or meaning-field predetermines what and how those consciousnesses can think. In short, the reality of language is not reducible to, or explainable solely in terms of, the operative reality of the conscious beings who realize the language. Thus, while consciousness is irreducibly subjective, meaning (and language) is irreducibly social in nature, while "mind" is simply the capacity to be aware of, to employ, or to operate on or with, meanings.[79]

Self-consciousness involves the capacity of an organism to be at the same time—in one unitary act—both the subject and object of its own awareness: to be an object "for itself." Little is more commonplace and yet mysterious than this taken-for-granted experience of everyday human existence. I will, of course, have much more to say of the existential significance of this experience later on. Here I simply wish to be clear about its nature and essential relation to consciousness and mind. It would seem that self-consciousness presupposes the existence of at least a rudimentary language or structured meaning-field. For it would seem to require some minimal sense of self about which to be reflexively conscious. And that would seem to require at least some quasi-linguistic capacity to use signs that would allow for the designation of an object such as one's self. Here is not the place for a discussion of the significance of the self, and its relation to its ambient biological and social field. But it is important to see that the capacity for self-consciousness seems to require that the conscious subject be able to have some more-or-less clear and articulate sense of being, specifiably distinguishable from the other beings within its field of awareness. In short, self-consciousness would seem to be consciousness mediated by mind, however elemental, and thus irreducibly social.

We are thus confronted with a unique emergent field characterized by both irreducible subjectivity and sociality, neither of which, furthermore, are reducible one to the other. Consciousness *is* the subjective structure of that experience. Self-consciousness is the meaningful organization of that experience as it locates itself within its own meaning-field. This field, by a necessity that is social as well as biological, must overlap with other such fields, and thus is, in principle, to some extent sharable—that is the objective basis of the possibility of communication. But it is, at the same time, inescapably subjective—and, where self-consciousness is in question, quite personal—and thus inevitably private, and to some extent inaccessible to the thought of another. We might well observe the (brain) processes that make this experience possible, but not the experience itself. We can observe the causal conditions but not the qualitative reality. We cannot experience the experience of the other—we cannot *be* the other, only *know* what natural processes are taking place—and hence, we cannot know the meaning that that experience has for the other. The other's intention—what it "means" and what it proposes to do—is an intrinsic property of its field of conscious awareness. It is *not* a property of the causal conditions of its awareness. Thus, an objective knowledge of those conditions is not equivalent to a subjective awareness of their meaning. Hence, from a knowledge of those conditions nothing necessarily follows about the meaning, intentions, or likely behavior that will emerge from that experience.[80]

We can see the profound significance of this emergent reality by contrasting the operative logics of natural or biological processes with that of human intentionality and purposeful behavior. To take but the simplest case: billiard balls operate in accord with fairly straightforward principles of causal determination—using Newton's laws of motion, calculate the force acting and the inertial mass being acted upon along with the coefficient of friction and the resultant behavior can be fairly accurately predicted. The event follows rather straightforward causal principles, without any consideration of purpose or goal. It might be suggested that certain biological reflexes operate similarly—and perhaps, even certain mental associations might follow a similar law of quasi-automatic causal connection.[81]

Contrast that situation with the linguistic (and behavioral) pattern determined by the desire to create an articulate sentence, however rudimentary. Here the connections between words are determined not by their physical or causal properties, but by their meaning. The operative logic of discourse "makes sense"; it organizes thoughts, feelings, images, and projects in accord with a logic of intention, determined both by the purpose of the subject and by the structure of the language. This intention, while in no sense violating the laws of physics or biology, can determine a distinctive course of action that will causally redirect those very natural processes that are the conditions of its possibility. The behavior of the natural scientist operates in a manner quite different from the causal laws he or she is seeking to unearth. In fact, the organization of an experiment presupposes the capacity of the inquirer to reorganize experience and restructure events in accord with a coherent set of meanings that is meant to produce an expectant result—one that would not have occurred but for the organized experimental situation that reflects the coherent application of a theoretically based system of elaborated meanings. The inquirer will "mind" the results to see whether or not the anticipated structure of meanings is confirmed by the causal behavior of the experimentally produced result. Thus, two quite distinctive operative logics are at work. The distinctive logic of intentionality is grounded in the unique being of self-conscious mentality, itself the ground and possibility of freedom. Freedom is thus precisely the nonreducible determination of intention, meaning, and actions that emerge from the uniquely personal reality of self-conscious subjectivity.[82]

This discussion prepares the ground for the reframing of the social sciences as dealing with an emergent, nonreducible, field that must be addressed primarily in terms of socialized meanings, that is, hermeneutically. Thus, any potentially adequate social theory will have to consider the manner in which the subjects "tell their story," thus scientifically grounding a dramatic and existential interpretation of individual and social life. Such a life can only take form, structure, meaning, and direction within the meaning frame of the ongoing drama of a specific historically institutionalized culture. But of this, more will be explained later.

A New Causal Paradigm

No doubt, the effort to offer an alternative causal logic strikes deep at the core of our inherited metaphysic. And rightfully generates much resistance. It seems so strange and counterintuitive. It seems to leave much wanting. I am claiming that the causal deductive logic that has undergirded Western thought for more than 2,500 years is inadequate, has led us down numerous blind alleys, and has left us knocking our heads against the proverbial brick wall in countless theoretical and practical domains, of which the freewill or determinism conundrum is only the most obvious and intractable. "Like other things one does not talk about, unclear thinking about what is fundamental can come back to haunt us later on. Its most insidious effect is to lead us out into the desert by inducing us to search on smaller and smaller scales for meaning that is not there."[83] But the proposed alternative will no doubt leave many people scratching their heads, and feeling that something is missing. Where is that tight deductive causality that predicts the behavior of the event as the logical consequence of the statement of existing conditions and specification of operable laws? Where is that dissection of complexes into self-evident and indubitable atomic simples out of which we can step-by-step reconstitute and thus fully and completely explain the resultant complex? What kind of determination can the past provide to the future? Haven't we simply waved our wand, overlooked the practical details, and created an illusory and quasi-magical field that none can see, or "sink their teeth into," and offered that as a new causal structure? Haven't we just obtained our results—and "solved" our metaphysical and practical problems—by giving up all pretension of seeking to completely understand the processes at work?

We might well recall here the now classical argument between Einstein and Neils Bohr over the adequacy of quantum mechanics. Einstein was convinced that quantum mechanics was an incomplete theory of reality because it was incapable in principle of predicting the behavior of a single quantum particle. Its theories only allowed statistical predictions for the behavior of aggregates. It was this situation that led to Einstein's famous remark that "God does not play dice with the universe." He was convinced that there were "hidden variables" that the theory failed to include that, if included, would complete quantum mechanics by allowing for precise predictions of the behavior of each individual particle.[84] For it was clearly Einstein's view that only such a classically deterministic theory could possibly be adequate. Much of the last thirty years of his life was dedicated to the design of thought experiments—the most famous being the Einstein-Podolsky-Rosen experiment—that sought to show, without success, the fundamental incompleteness of quantum theory. Einstein's metaphysical faith in the priority of Aristotelian logic is one of the key reasons for calling him the last of the classical physicists.

The purpose of these remarks has been to suggest the fundamental inadequacy of that classical way of thinking—first systematized by Aristotle more than 2,300 years ago and which has dominated Western thought ever since—and to offer a conceptual frame for an alternative with which to replace it. It is clearly well beyond my powers or intent to claim to have proven the correctness of this position, or to claim to have definitively demonstrated the nature and structure of this metaphysical field theory and to have provided a detailed and convincing description of its operation in a vast range of domains. Rather I have sought to set forth what might be called a metaphysical research program—inviting and challenging others to seek either to refute my critique or to carry out the investigations that will instantiate my claims. An alternative paradigm can invite inquirers to ask new questions, look to new places for information, and use new models for the framing of theories—but the facts will have their say.

It is, of course, always appropriate to try to find linear causal pathways wherever the facts warrant—but we must avoid getting caught in that dead-end box. More and more people and investigators in different fields are coming to realize the need for a systems approach—both because of the inherent complexity of serious problems and because of what I take to be the fundamental, pervasive, and nonreducible reality of structured fields or levels of being. What I propose to show throughout the remainder of this work is the theoretical and practical fruitfulness of recasting some social and cultural studies in field-theoretic terms.[85]

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[1] Laughlin, p. 20.
[2] Quoting Donella Meadows, in Wheatley, p. 10.
[3] Daly, pp. 20–22.

[4] To give but a few examples, randomly selected, in a series of lectures for The Teaching Company on *The Neurophysiology of the Brain,* Professor Robert Sapolsky says that depression involves "faking out" the hypothalamus, and the use of a "singulotomy"—"a single bundle cut"—to cut the signals from cortex to hypothalamus "proves" that this "disease" is neuroanatomically caused. Patricia Churchland made essentially the same reductionist point in a talk given at the State University of New York at Stony Brook on March 10, 2008. In *Wider than the Sky,* Gerald Edelman makes precisely this same reductionist assumption, of which more will be explained in the following note.

[5] One of the more influential contemporary versions of this position is that offered in exquisite detail by Daniel Dennett. With his discussion of "sky hooks and cranes" and his strategy for "discharging the homonculii" he claims to have provided a program for the complete explanatory reduction of consciousness to brain states, of "folk psychology" to neuroscience. While he claims to have "explained" consciousness, I believe that it would be far more correct to see him as offering a reductionist research program that itself is rooted in some overstated and often highly dubious factual and theoretical claims—more an expression of desire than of scientific fact.

Perhaps even more illuminating is the approach of the distinguished Nobel Laureate for Physiology or Medicine, Gerard Edelman. Presenting an evolutionary theory of consciousness that he calls "neural Darwinism or the theory of neuronal group selection" (Edelman, p. 33), he asserts that "a theory of consciousness . . . must accept the fact that the physical world is causally closed—only forces and energies can be causally effective. Consciousness is a property of neural processes and cannot itself act causally in the world. As a process and an entailed property, consciousness arose during evolution of complex neural networks with a specific kind of structure and dynamics. Before consciousness could emerge, certain neural arrangements must have evolved. These arrangements lead to reentrant interactions, and it is the dynamics of reentrant networks that provide the causal bases that entail conscious properties. Such networks were chosen during evolution because they provided animals with the ability to make high-level discriminations, an ability that afforded adaptive advantages in dealing with novelty and planning" (Edelman, p. 140). But this assertion just rules out emergent properties by definition. He simply assumes that there are only two possible alternatives, a reductionist physicalism or what I might call a dualistic "mentalism." He argues that "neuronal variability" is crucial to provide the basis for evolutionary selection. He asserts that consciousness is not an epiphenomenon of the brain, but was selected by evolution—and yet he claims it is entirely reducible to the deterministic properties of the closed system of neuronal chemistry and "cannot itself act causally in the world." But there seems to be an evident incoherence here, since if emergent properties are ruled out in advance, it is not clear why and how it would have been evolutionarily selected if it were not able to act causally in the world. It would seem that he can't have it both ways. Either consciousness can act in the natural world, and thus can be "selected" by evolution, or it can't so act, and then it must be an irrelevant epiphenomenon. It would seem that Edelman is boxed in by the metaphysical framework within which he is unselfconsciously trapped.

[6] Rorty, p. 9.

[7] Bhaskar, p. 130. "The very statement of the eliminativists' [that is, material reductionists'] claim presupposes the non-vacuous use of the concepts which the eliminativist contends are vacuous. For the mere use of language in making assertions and asking questions presupposes the applicability of such concepts as intention, meaning something by what one says, knowledge and belief, having reasons and being able to give reasons, understanding and explaining. Does the eliminativist believe what he says—or does he not believe what he says, as the cooling of water in a jug does not involve the transfer of caloric? Or does he neither believe nor not believe? Does he intend to convince his readers of the truth of his words? Or does he not so intend, as the oxidation of iron does not involve any phlogiston? Is his utterance intentional? Or unintentional! If it is not intentional, nor yet unintentional, neither accidental nor inadvertent, is it an utterance at all? If he neither means what he says nor means anything by what he says, has he actually said anything at all? Does he expect us to be persuaded by his arguments? Does he have reasons for saying what he says, or is he speaking without reason? Does he have reasons for what he says, or are his contentions unfounded dogmatism? Obviously, he claims to be offering many different reasons for his strange theory. But can a being have reasons for certain claims, and yet neither believe nor fail to believe that these reasons support the claims? And so on. The eliminativist saws off the branch upon which he is perched. For if what

he claims were true, his utterances could not be taken to be assertions, or claims, and his supporting arguments could not be taken to be reasons for believing what he says" (Hacker, p. 377).

[8] In a quite different idiom, English analytical philosophy, largely under the influence of the later works of Ludwig Wittgenstein, pursues a quite similar path in its discussion of the irreducibility of the "logical grammar" of everyday speech. See, for example, the quite recent, highly technical, and often insightful *Philosophical Foundations of Neuroscience,* by M. R. Bennett, and P. M. S. Hacker (Malden, MA: Blackwell, 2003), throughout referred to as "Hacker," since he is the primary philosopher among the authors of the text, excerpts from which were cited in the previous endnote, of which more will be explained later.

[9] It would actually be more precise to speak of "physicalism" rather than materialism because, as will be emphasized later, the "material" world is made up of energy as well as matter. But, with this point clarified, we will let normal parlance dictate our mode of expression.

[10] One further possibility, which is probably also Whitehead's, is that in some way spirit is pervasively present in all matter from the beginning. But that hardly seems credible to me based on the facts as we know them.

[11] Silver, p. 234. Laplace's actual statement was: "We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at any given moment knew all the forces that animate nature and the mutual positions of the beings that compose it, if this intellect were vast enough to submit the data to analysis, could condense into a single formula the movement of the great bodies of the universe and that of the lightest atom; for such an intellect nothing could be uncertain and the future just like the past would be present before its eyes" (quoted in Lindley [1], p. 22).

[12] Silver, p. 239.

[13] Ibid.

[14] Ibid., pp. 240, 244, 250.

[15] Ibid., p. 238.

[16] "Kurt Gödel revealed that any mathematical system is always incomplete . . . that is, there are always questions that can be posed in any mathematical structure that cannot be proved true or false. This, at some point, must also carry implications for the enterprise of theoretical physics in any quest to finally reduce all of nature into a basic set of defining equations. . . . Mathematics itself defies a complete mathematical analysis. . . . No logical proof exists of all the theorems one can pose in a mathematical system" (Lederman, p. 75). "Any mathematical system containing a finite number of axioma is therefore 'incomplete'—the content of Gödel's theorem" (Lederman, p. 325). In addition to Gödel's "undecidability" proof of the essential incompleteness of any system at least as complicated as arithmetic, Alan Turing demonstrated that there is no effective decision procedure, or algorithm, for arithmetic. Of course, he also laid the foundation for the computer industry by showing how one could design a system—a "Turing machine"—that could decide any question for which an algorithm could be written.

[17] This is made clear by Stephen Hawking in his discussion of the "big bang singularity," to which he counterposes his conception of negative time, an explanation of which will not be attempted here. Nor will I consider alternative theories of colliding brane worlds, none of which would seem to affect the point being made here.

[18] A classic statement of Mechanistic Reductionism is that of C. D. Broad in *The Mind and its Place in Nature:* "[There] is one and only one kind of material. Each particle of this obeys one elementary law of behaviour, and continues to do so no matter how complex may be the collection of particles of which it is a constituent. There is one uniform law of composition, connecting the behaviour of groups of these particles as wholes with the behaviour which each would show in isolation and with the structure of the group. All the apparently different kinds of stuff are just differently arranged groups of different numbers of the one kind of elementary particle; and all the apparently peculiar laws of behaviour are simply special cases which could be deduced in theory from the structure of the whole under consideration, the one elementary law of behaviour for isolated particles, and the one universal law of composition. On such a view the external world has the greatest amount of unity which is conceivable. There is really only one science, and the various "special sciences" are just particular cases of it" (quoted in the article on "*Emergent Properties*" in the *Stanford Encyclopedia of Philosophy,* p. 3).

[19] See my further discussion of Aristotelian logic in the section "The Nature of Emergence."

[20] Silver, p. 223.
[21] Ibid., pp. 221–222, 224.
[22] Ibid., p. 220.
[23] Ibid., p. 219.
[24] By which I mean the different quarks, electrons, and neutrinos.
[25] Lindley, p. 14. In classical situations, uncertainty and probability are simply matters of our lack of information, inadequate theories, or processing power—they are "technical" problems—while in quantum mechanics they seem to be intrinsic properties of reality itself. "Predictions in quantum mechanics are probabilistic not because of insufficient information or understanding, but because the theory itself has nothing to say" (Lindley, p. 25).

"The Copenhagen interpretation is, fundamentally, the uncertainty principle writ large. In its simplest form, the uncertainty principle puts limits on what we can know: you can't know both the speed and position of an electron; you can't measure its spin in both an up-down and a left-right sense at the same time. More elaborately, you can't ask to see an interference pattern and also know which way the photon went. And finally, you can't infer what's "really" going on in one kind of experiment and expect it to be consistent with what's "really" going on in a modified, and therefore different, version of that experiment. That's the Copenhagen interpretation, more or less" (Lindley, p. 71). Decoherence essentially resolves the measurement problem and explains how quantum weirdness and uncertainty can be compatible with classical determinism. "At every step, as we say, decoherence erases quantum superpositions but does not and cannot choose between different possible outcomes of a quantum measurement. . . . We can choose to measure different things. We can measure the polarization state of a photon with respect to this angle or that; we can measure the spin of an electron in an up-down or left-right sense, or anything in between; we can measure the position or the momentum of a particle, or some limited combination of the two. And once we have made such a measurement, we set in motion a chain of events that becomes irrevocable. Depending on the outcome of an experiment, a memorable paper might get published in a scientific journal, or a cat may die. The paper can't later be unpublished; the cat can't be restored to life.

Any quantum measurement, or series of measurements, can set in motion a chain of classical events, one thing following another in familiar manner. But once one chain of events happens, other possible chains of events cannot. Decoherence guarantees that a chain of events rather than a continuously ill-defined stream of quantum possibilities actually takes place. But it doesn't tell us which chain of events is going to happen. Probability has not been erased; measurements can have several different outcomes, and we cannot predict which" (Lindley, pp., 219–220).

[26] "For example, two photons, by definition, traveling at the speed of light, (which it seems is the fastest possible speed, (certainly nothing traveling at a lesser speed can be accelerated up to that speed, according to General Relativity)) moving in opposite directions from an atom that has emitted them, retain an immediate nonlocal connection, such that if polarization of one is measured, the other will instantly have the opposite polarization, even though the polarization of each particle was not determined until the moment the measurement was taken. This is known as *quantum entanglement*" (Sheldrake, p. 307).

[27] Ibid. Thus, while the quantum world whenever it is tested always appears to be constituted by discrete elements, the manner of its appearance reveals logical patterns of interconnection that suggests a networked and relational field out of which these discrete quanta emerge and return—as with the virtual particles that emerge from the vacuum of "empty space." This is the apparent reality of the Schrodinger wave equations that describe the probability of the appearance of the quanta when the wave function is "collapsed" upon its interaction with an "observer." This relational reality that seems to describe the behavior of the most fundamental subatomic world may explain the fundamental and pervasive reality of conservation laws, as more basic than the particles of which the Newtonian world was supposed to be constituted. It is this fact that David Böhm was trying to express with his conception of an "implicative order."

[28] "In other words, to reinforce the point we already made, an electron by itself is not described by one unique wave function; the way you describe it, the wave function you use, depends on what you plan to measure. And although the wave function obviously depends on the state of the electron, and on what you know about it, it can be misleading to think that the wave function somehow 'is' the electron. It's better to say that a wave function describes a system—the thing being measured and the measurement being made—rather than being an independent description only of the thing being measured" (Lindley, p. 47).

[29] Laughlin, p. 18. Errol Harris quotes Louis De Broglie: "The particle truly has a well-defined individuality only when it is isolated. As soon as it enters into an interaction with other particles, its individuality is diminished. . . . In the cases contemplated by the new mechanics, where particles of the same nature occupy, somehow simultaneously, the same region of space, the individuality of these particles is dissipated to the vanishing point. In going progressively from cases of isolated particles without interactions to the cases just cited, the notion of the individuality of the particles is seen to grow more and more dim as the individuality of the system more strongly asserts itself. It therefore seems that the individual and the system are somewhat complementary idealizations. This, perhaps, is an idea which merits a more thorough study" (Harris, pp. 136–137). Harris then continues: "The chemical valency of any element depends on the number of 'unpaired' electrons in the outer shell—that is, those unmatched by electrons with opposite spin but otherwise identical quantum numbers. The resulting physical and chemical properties are, therefore, the characteristics of wholes, which their parts do not separately possess, but which arise in consequence of their ordered combination, and the exclusion principle proves to be one of organization and structural pattern governing the arrangement of particles upon which these new properties depend. A striking example of this is given by Margenau. Two hydrogen atoms may attract one another, combine and form a molecule, but any third atom which may now approach is repelled. The mutual attraction (or, when it occurs, repulsion) between single atoms may be accounted for by ordinary dynamic laws, but the repulsion of the third by two adhering atoms is a consequence of the exclusion principle and is attributed to what is called 'saturation' of forces.

The influence of the principle makes itself felt again in the structure of crystals, directly or indirectly through atomic structure. Here again, new properties are displayed which are wholly dependent upon composition and are unforeshadowed in the parts compounded. They are not present in the single atoms but depend on the way in which they are arranged in the combination. Margenau lists ferromagnetism, optical anisotropy and electrical conductivity among these and designates them all 'co-operative phenomena.' . . . "The mutual inter-play of these fields of force, in short, makes it fair to say that the atom is a single complex system of mutually determining fields, none of which exists in isolation in the form it assumes in inter-relation with the others, but each of which is a distinguishable feature of the articulated structure of the indivisible whole" (Harris, pp. 138, 140, 144–145).

[30] Cf. Chapter 3.

[31] The development of symbolic logic has not changed anything as far as this issue is concerned. It has, however, pointed out the reality of relationships that have properties that are not themselves simply reducible to the qualities of the things being related—a fact of immense significance for the argument I am developing.

[32] A point further underscored by the nineteenth-century "discovery" of non-Euclidean geometries that effectively severed any simple and direct identification of the processes of (mathematical) reasoning with objective reality. How to account for the remarkable effectiveness of mathematics as a tool for explaining objective reality remains a controversial issue to the present day, but one thing is clear: the scientific application of mathematical theories remains an empirical question, as does the appropriateness of applying such Aristotelian "metaphysical certainties" as the principles of Non-Contradiction and Excluded Middle.

[33] Another important example is Charles Sanders Peirce's discussion of the creative logic of "abduction."

[34] "No amount of neural knowledge would suffice to discriminate between writing one's name, copying one's name, practising one's signature, forging a name, writing an autograph, signing a cheque, witnessing a will, signing a death warrant, and so forth. For the differences between these are circumstance-dependent, functions not only of the individual's intentions, but also of the social and legal conventions that must obtain to make the having of such intentions and the performance of such actions possible" (Hacker, p. 357).

[35] There is an extensive literature on this issue, but the word is not always used with precisely the same meaning. For a very nice, though somewhat technical, overview of the field, as well as for an extensive bibliography, check out the entry in the previously mentioned *Stanford Encyclopedia of Philosophy* article on "Emergent Properties" located at http://plato.stanford.edu/entries/properties-emergent/.

[36] From now on I will just abbreviate "powers and modes of operation" as "causal powers."

[37] The authors of the previously cited *Stanford Encyclopedia of Philosophy* article on "Emergent Properties" summarize the views of emergentists as follows: "Ontological emergentists see the physical

world as entirely constituted by physical structures, simple or composite. But composites are not (always) mere aggregates of the simples. There are layered strata, or levels, of objects, based on increasing complexity. . . . Emergent laws are fundamental; they are irreducible to laws characterizing properties at lower levels of complexity, even given ideal information as to boundary conditions. Since emergent features have not only same-level effects, but also effects in lower levels, some speak of the view's commitment to 'downward causation'" (p. 8). They further elaborate on the consequences of emergence: "If emergence obtains, theorists would be forced to rest content with a hierarchy of various sciences ranging from the universal—physics—to the most specific (Broad, 1925, p. 77). while Emergentists, too, are physical substance monists ("there is only fundamentally one kind of stuff"), they recognize 'aggregates [of matter] of various orders'—a stratification of kinds of substances, with different kinds belonging to different orders, or levels. Each level is characterized by certain fundamental, irreducible properties that emerge from lower-level properties. Correspondingly, there are two types of laws: (1) 'intra-ordinal' laws, which relate events within an order, i.e., a law connecting an aggregate of that order instantiating a property of that order at a time with some aggregate of that order instantiating some other property at a certain time; and (2) 'trans-ordinal' laws, which characterize the emergence of higher-level properties from lower-level ones. Emergent properties are identified by the trans-ordinal laws that they figure in; each emergent property appears in the consequent of at least one trans-ordinal law, the antecedent of which is some lower-level property" (p. 3).

[38] Even that may not be correct, as Laughlin observes. "It is not uncommon for a committed reductionist to dismiss the evidence of the fundamental nature of collective principles on the grounds that there actually is a deductive path from the microscopic that explains the reproducibility of these experiments. This is incorrect. The microscopic explanation of temperature, for example, has a logical step called the postulate of equal *a priori* probability—a kind of Murphy's law of atoms—that cannot be deduced and is a succinct statement of the organizing principle responsible for thermodynamics. The ostensibly deductive explanations of the Josephson and von Klitzing effects always have an "intuitively obvious" step in which the relevant organizational principles are assumed to be true. They actually are true, of course, so the reasoning is correct, but not necessarily in the sense the reasoner intended. In deference to reductionist culture, theorists often give these effects fancy names, which, on close inspection, are revealed to be nothing more than synonyms for the experiments themselves. In neither case was the great accuracy of the measurement predicted theoretically" (Laughlin, pp. 19–20).

[39] One may become quite technical in the discussion of types of materialist reduction: for example, derivational, explanatory (one level by another, as with Dennett's discussion of the "personal" and the "subpersonal"), and eliminative (with the Churchlands). In their discussion of reductionism, Bennett and Hacker make the following points: "ontological reductionism . . . holds that one kind of entity is, despite appearances to the contrary, actually no more than a structure of other kinds of entity. Side by side with the ontological reductionism, . . . [there is] *explanatory reductionism:* 'The scientific belief . . . that our minds—the behaviour of our brains—can be explained by the interactions of nerve cells (and other cells) and the molecules associated with them.' The reductionist approach, Crick explains, is that 'a complex system can be explained by the behaviour of its parts and their interactions with each other. For a system with many levels of activity, this process may have to be repeated more than once—that is, the behaviour of a particular part may have to be explained by the properties of *its* parts and their interactions.' . . . In the broadest sense, reductionism is the commitment to a single unifying explanation of a type of phenomenon. In this sense, Marxism advocates a reductive explanation of history, and psychoanalysis defends a reductive explanation of human behaviour. More specifically, reductionism in science is a commitment to the complete explanation of the nature and behaviour of entities of a given type in terms of the nature and behaviour of their constituents. The ideal of 'unified science,' advocated by the Vienna Circle positivists in the 1920s and 1930s and adopted by the later logical empiricists in the 1950s, was committed to what has been called 'classical reductionism.' This conception held that the objects of which the world consists can be classified into hierarchies such that the objects at each level of classification are composed of objects comprising a lower level. The lowest level was conceived to be constituted by the elementary particles investigated by fundamental physics. Above this, in successive levels, lie atoms, molecules, cells, multicellular organisms and social groups. Investigating each level is the task of a given science (or sciences) the purpose of which is to discover the laws that describe the behaviour of entities of the kind in question. The reductivist programme is to see the laws of any given level derived from the different laws

describing the behaviour of entities at the lower level. *Derivational reduction,* thus conceived, requires, in addition to the laws at the reduced and reducing levels, bridge principles identifying the kinds of objects at the reduced level with specific structures of objects comprising the reducing level" (Hacker, pp. 355, 357).

[40] Searle, pp. 55–56. This is but one of the many places in which he discusses this issue.

[41] Bhaskar, pp. 125–126. In his *A Realistic Theory of Science* and *The Possibility of Naturalism,* Bhaskar offers a brilliant and incisive critique of much contemporary Philosophy of Science, with a particularly devastating dissection of the causal theories of Hume. He shows that the presuppositions of scientific theory and practice argue for the objective reality of causal laws in nature and society, each in their own way. My analysis draws heavily upon his theory of "transcendental realism."

[42] "Without language, we are but naked apes. Without the language of psychological expressions, we are not self-conscious creatures. Without self-consciousness, we are not moral beings. For what makes us human is what flows from possession of a rich language. And our psychological language is not merely a descriptive instrument for the characterization of what we observe around us. It is partly constitutive of the phenomena that it is also used to describe, precisely because the first-person, present-tense use of psychological verbs is typically a criterion for others to say 'He believes (wants, intends, etc.)'. The use of these phrases in the first-person present tense is characteristically to express a belief, want or intention. The paradigmatic expressions of distinctively human intentions and desires, thoughts and beliefs, loves and hates, are verbal. They are not descriptions of the inner, but manifestations of it. And for a wide range of psychological attributes and their objects, what is thereby manifest is something that is possible only for a creature that has mastered the use of the psychological vocabulary in all its multiplicity and diversity, the use of which is partly constitutive of what it is to be human" (Hacker, p. 375).

[43] In a presentation to the Community Advisory Council (CAC) at the Brookhaven National Laboratory (BNL), Doon Gibbs, associate lab director for Basic Energy Sciences and interim director of the Center for Nanoscience (CFN), observed that gold in bulk is nonreactive, but at the nanoscale (e.g., 100 gold atoms) is quite reactive, and can take sulfur out of the air in catalytic converters. It is the "collection of atoms that give us its properties," not the individual atoms by themselves, he said (10/12/06). Thus, the properties are qualities of the field, not of the elements themselves. Steve Hoey, CFN Environmental Safety and Health Coordinator at BNL, added that "copper nanoparticles smaller than 50 nm are super hard materials that do not exhibit the same malleability and ductility as larger forms of copper." At the previous month's meeting of the CAC, Steve Dierker, associate lab director for Light Sources at BNL, used the "mechanisms of molecular *self-assembly*" that take place "at the lower end of the nanoscale size range" as one example of "the science of *emergent behavior,* which arises from cooperative behavior of individual components of a system," thus emphasizing that the systemic properties are not deducible from the properties of their constituent elements (9/8/06).

[44] Laughlin, p. 35. Laughlin continues that thought as follows: "Ironically, the immense reliability of phase-related phenomena makes them the reductionist's worst nightmare—a kind of Godzilla set loose by the chemists to crush, incinerate, and generally terrorize their happy world. A simple, universal phenomenon one encounters frequently cannot depend sensitively on microscopic details. An exact one, such as rigidity, cannot depend on details at all. Moreover, while some aspects of phases are universal and thus easy to anticipate, others, such as which phase one gets under which circumstances, are not—water being an especially embarrassing case in point. Ordinary water ice displays, at last count (the number keeps rising due to new discoveries) eleven distinct crystalline phases, not one of which was correctly predicted from first principles. . . .

Phases are a primitive and well-studied case of emergence, one that conclusively demonstrates that nature has walls of scales: microscopic rules can be perfectly true and yet quite irrelevant to macroscopic phenomena, either because what we measure is insensitive to them or because what we measure is overly sensitive to them. Bizarrely, both of these can be true simultaneously. Thus it is presently too difficult to calculate from scratch which crystalline phase of ice will form at a given temperature and pressure, yet there is no need to calculate the macroscopic properties of a given phase, since these are completely generic.

A measure of the seriousness of this problem is provided by the difficulty of explaining clearly how one knows phases to be organizational. The evidence always manages to be complicated, indirect, and annoyingly intermingled with theories—not unlike the evidence of product superiority in a commercial for soap or cars. The deeper reason in each case is that the logical link from the fundamentals to the conclusion is not very substantial. One thing we know for certain is that crystalline solids are ordered lattices of atoms—a fact revealed by their tendency to deflect X-rays through specific angles—while liquids and gases are not. We also know that systems with small numbers of atoms are motivated by simple, deterministic laws of motion and nothing else. We also know that attempts to discover the scale at which these laws cease to work or are supplanted by others have failed. And finally, we know that elementary laws have the ability in principle to generate phases and phase transitions as organizational phenomena" (Laughlin, pp. 34–35).

"Once one knows what to look for, the organizational nature of phases other than the solid becomes easy to demonstrate. A collective state of matter is unambiguously identified by one or more behaviors that are exact in a large aggregation of the matter but inexact, nonexistent, in a small one. Since the behavior is exact, it cannot change continuously as one varies external conditions such as pressure or temperature but can change only abruptly at a phase transition. One unambiguous signature of an organizational phenomenon is therefore a sharp phase transition. The transition itself, however, is only a symptom. The important thing is not the transition but the emergent exactness that necessitates it.

The melting and sublimation transitions of ice signal the demise of crystalline order and its replacement by a set of exact behaviors known collectively as hydrodynamics. The laws of hydrodynamics amount to a precise mathematical codification of the things we intuitively associate with the fluid state, such as the meaningfulness of hydrostatic pressure, the tendency to flow smoothly in response to differences in pressure, and the rules of viscous drag" (Laughlin, p. 40).

"The crystalline and superfluid phases, and their attendant exact behaviors, are specific examples of an important abstract idea in physics called spontaneous symmetry breaking. It has uses ranging from engineering to the modern theory of the vacuum of space and is even suspected of being relevant to life. The idea of symmetry breaking is simple: matter collectively and spontaneously acquires a property or preference not present in the underlying rules themselves. For example, when atoms order into a crystal, they acquire preferred positions, even though there was nothing preferred about these positions before the crystal formed. When a piece of iron becomes magnetic, the magnetism spontaneously selects a direction in which to point. These effects are important because they prove that organizational principles can give primitive matter a mind of its own and empower it to make decisions. We say that the matter makes the decision "at random"—meaning on the basis of some otherwise insignificant initial condition or external influence—but that does not quite capture the essence of the matter. Once the decision is made, it becomes "real" and there is nothing random about it anymore. Symmetry breaking provides a simple, convincing example of how nature can become richly complex all on its own despite having underlying rules that are simple.

The existence of phases and phase transitions provides a sobering reality check on the practice of thinking of nature solely in terms of the Newtonian clockwork. Floating on the lakes of Minnesota and stretching into the sky in large cities are simple, concrete examples of how organization can cause laws rather than the reverse. The issue is not that the underlying rules are wrong so much as that they are irrelevant—rendered important by principles of organization. As with human institutions, emergent laws are not trustworthy, and sometimes hard to discern, when the organization is small, but they become more reliable as it grows in size and eventually become exactly true" (Laughlin, pp. 44–45).

[45] "Can Science Explain Everything? Anything?" *The New York Review of Books* 48, no. 9 (May 31, 2001): 48.

[46] "A cellular automaton is a simple computational mechanism that, for example, changes the color of each cell on a grid based on the color of adjacent or nearby cells according to a transformational rule" (Kurzweil, p. 85).

[47] My former colleague Eric Walther provided me with the following useful example, drawn from an article by Martin Gardner that appeared in *Scientific America:* "Consider the 'Game of Life' (Conway). The Game evolves on an infinite grid (given a somehow-defined initial configuration) in which each cell is either active (alive) or not. There are three simple rules that determine, from the prior state of a cell's eight immediate neighbors, whether that cell will be currently active or not. (One of the three rules is: 'If exactly three neighbors are active, the cell becomes active.') If you spend a few hours playing the game, you discover a universe of entities with well-defined behavior patterns that propagate endlessly or until interfered with by some other behavior pattern. The simplest type of entity is a 'flasher,' a local pattern that doesn't move across the grid but alternates between two states.

The simplest flasher is:

* *
* -> * * * -> * -> etc.
* *

Some of the other simple entities are puffers, gliders, and eaters. An eater ‘eats’ a glider when the glider collides with it. Now the question is this: is the eater/glider law ‘reducible to’ the three rules? There is absolutely no way [for us humans anyway] of understanding the necessity of that law directly from the three rules; you have to draw the grid and ‘see how the rules play out.’ (Of course this is a “non-empirical” sort of experimentation.) So maybe we should say that the law is ‘not reducible to’ the rules. On the other hand it would seem silly to talk about ‘emergence’ in a purely abstract system where everything that ‘happens’ is a necessary consequence of the rules. For example, I think Darwinian adaptations are an equally necessary (though unpredictable in the abstract) consequence of statistical principles. Likewise for chemistry vis-à-vis quantum physics.”

[48] No one has presented this “substantive metaphysics”—the metaphysics of “substance”—in clearer and more unequivocal terms than Spinoza. For him, the causal structure of the natural world is an exact expression of the mathematical structure of geometric proof, and precisely as determinate. For him, freedom is but the expression of inadequate ideas that the further development of science will dispel. It is this mathematical structure of the natural world to which Einstein was alluding when he said that he “believed in the god of Spinoza.” And it is to counter the updated versions of that position that this argument is primarily directed.

[49] In fact, according to the Nobel Laureate Frank Wilczek, while the fundamental reality of mass is just assumed by Newton, Einstein has shown not only that mass and energy are interchangeable but also that mass is best thought of as the energy of fundamental particles left over from the “big bang” (from a talk at the BNL, on 4/21/06).

[50] Lederman and Hill, p. 151.

[51] Ibid., p. 153.

[52] Einstein and Infield, pp. 242–243.

[53] In that same talk at BNL, Wilczek said that “empty space is in reality a widely dynamical medium,” and “the different particles we observe correspond to the vibration patterns that occur in this dynamical void when it is disturbed in various ways.” Thus, matter is made up out of the particles, which are “stable patterns of equilibrium” that emerge out of this quark-gluon field. No wonder Einstein’s reference to this vision as “the highest form of musicality,” a sort of modern version of the “music of the spheres.”

[54] Harris very nicely summarizes this entire development and the radical revision it calls for as follows: “The twentieth-century revolution in physics presents us with a conception of physical nature so radically different from that entertained by classical physics that the philosophical outlook conditioned by the latter is no longer viable either as a metaphysical theory or as a tacit presupposition of other sciences. . . . In deposing the old ideas, contemporary physics has not enthroned their equally outdated philosophical rivals, it has evolved out of them something significantly different from either.

This has been done in two main phases, which have been historically concurrent. First, the theory of relativity completely transformed the conception of the world in space and time. From a vast collection of individualized particles externally related to one another and to the infinitely extended containers, space and time, which were independent not only of them but also of each other, it transformed the idea of the world into one of a single, continuous, unbroken space-time whole, constituted by a web of interrelated events themselves determined by the geometrical properties of the field in which they occur and from which they and the physical properties of the entities participating in them are inseparable” (Harris, p. 37).

“What classical physics conceived as an indivisible, hard, irreducible atom, quantum physics sees as a physical system in which the elementary particle is, as it were, in solution. Within this system, and in its systematic inter-relation with other elements, the particle is sometimes distinguishable but is inextricable as a separate entity. For the isolable mass-point of classical physics, the quantum theory substitutes what may be styled a physical pattern, or Gestalt, identifiable as a whole and containing within it distinguishable features. These may sometimes be represented as if they were particles, sometimes as if they were waves, but they are not themselves identifiable as separable and individualized entities. Here again all relations prove to be internal, and the system takes precedence over the particular components in the mutually constitutive inter-play of primal activity.

The physical world is thus seen as a macroscopic totality encapsulating within it microscopic totalities all constituted on similar principles of unified order. It is a complex system to which the constituent elements are integral and mutually formative. In the light of this conception, any talk of atomic facts is wholly incongruous and the sort of logic based on mutually independent propositions is obviously inappropriate. Necessary connections, which Hume had banished, are now seen to be indispensable, and the idea of factual truths that are both synthetic and logically cogent, so far from being evidently impossible as empiricists maintain, is inescapable. If the implications of modern physics are taken seriously, whole edifices of current philosophy must be assigned to the house breakers and a new metaphysic and a new logic must be sought" (Harris, p. 38).

"The picture of a world of mass-points, of bodies consisting of aggregates of such particulate masses, moving in an absolute field of space and time, has thus been transformed into one of a unified space-time continuum, in which events can be distinguished, but out of which they cannot be dissected—events constituted by their mutual relations in a world of correlative elements, inseparable and interdependent, constituting a single complex whole.

An intermediate stage between the conception of a particulate universe and the four-dimensional space-time world, was marked by the notion of 'field' that came into the foreground of physical theorizing with the development of electro-dynamics. A charged particle or a magnet is surrounded by a configuration of lines of force along which a free body subject to electrical or magnetic forces will be accelerated in the direction in which the force acts. This configuration is known as the field of force of the particle or the magnet. The direction of movement of a test body is described as being from a higher to a lower potential of the force, and the field might be defined as the structure or distribution of potentials associated with the source of energy. When the interrelation of electric and magnetic forces had been recognized, the electromagnetic field was defined and the equations determining its structure were evolved by Clerk Maxwell. In the first instance, it was the attempt to understand electromagnetism in terms of the classical notions of forces acting between particles that gave rise to the idea of the field.

As the field fills the whole of space and time, no part of the physical universe is completely unaffected by it (even though, for most practicable purposes, its effects may cease to be considerable beyond a limited region). The introduction of the concept, therefore, indicative of the crumbling of the classical mechanics, gives rise to a more unified picture of the material world, in which every particle becomes, in a sense, all-pervasive and each becomes involved with every other in a complex of overlapping fields. For every particle is the centre at least of a gravitational field and may also have electrical and magnetic fields associated with it, the limits of none of which can be sharply drawn and which modify the physical environment of every other particle" (pp. 52–53).

"The universe is thus a texture of relations between parts which though distinguishable, as they must be to be related, are not merely inseparable but intrinsically interdependent. The existence and character of each is what it is because the rest of the universe, *in toto* and *in minutiis*, are what they are. Whole and part are mutually determining and no detail could be other than it is without making some difference, however slight, to all the rest. This is no mere unverifiable 'metaphysical' speculation (in the pejorative sense), but the conclusion forced upon us by scientific theories based upon scientifically ascertained facts" (p. 107).

[55] "'Field' is the name physicists give to any quantity that permeates space. For example, the value of the gravitational field at any point tells how strong the effect of gravity is there. The same goes for any type of field: the value of the field at any location tells us how intense the field is there" (Randall, p. 153).

[56] I have recently (in the summer of 2000, to be precise) come across the very stimulating, suggestive, and controversial work of Ruppert Sheldrake. He has engaged in extensive research activity, seeking to develop experimental tests for his theories of morphogenetic fields, morphic resonance, and formative causation. While my analysis has been carried out in complete independence, and without knowledge, of his work—whether or not that can be taken as evidence of the truth of formative causation, I leave to others to consider—the claims he makes and the evidence he presents, if adequately confirmed, would certainly provide an additional level of support for the theories being here developed. In any case, the argument here

developed does not in any way depend upon the truth of the theories and evidence presented by Professor Sheldrake.

[57] Laughlin (p. 7) uses "law" to refer both to the theories that describe the operations of a system and to the natural processes and structures that determine its operation.

[58] Yoga meditation provides an excellent experiential example of the duality of concentration or focus and merging or dissipation of centers.

[59] James' pragmatism was his effort to ground the meaning of statements in the experienced consequences to which they led. With his radical empiricism, he tried to provide a metaphysical foundation for his pragmatism by rooting it in a more phenomenologically accurate description of experience as it is actually undergone, instead of the then more traditional (quasi-Humean) assertion of simple discrete (atomic) sensations or "impressions." In his *Psychology,* James had beautifully described the prereflective "flow" of experience as expressed in the comment on the experience of thunder. In his radical empiricism, he sought to "ontologize" that psychological experience, treating it as the metaphysical foundation of what is truly real. Thus meaning comes to be seen as an expression of intention, essentially a construct of the way we choose to carve up our experience.

[60] Heisenberg, p. 96.

[61] Quoted in Harris, p. 131.

[62] Ibid., p. 136: "P. W. Bridgman holds the same opinion: 'We do not have a simple event A causally connected with a simple event B, but the whole background of the system in which the events occur is included in the concept and is a vital part of it . . . The causality concept is therefore a relative one, in that it involves the whole system in which the events take place.'"

[63] Lindley, p. 14. In classical situations, uncertainty and probability are simply matters of our lack of information, inadequate theories, or processing power—they are "technical" problems—while in quantum mechanics they seem to be intrinsic properties of reality itself. "Predictions in quantum mechanics are probabilistic not because of insufficient information or understanding, but because the theory itself has nothing to say" (p. 25).

[64] Cf. ibid., p. 20.

[65] Ibid., p. 47. In the words of Lederman: "The orbitals of electrons in atoms therefore don't look anything like Kepler's orbiting planets about the sun. They are fuzzy things, trapped waves, the electron never having a definite position and momentum at the same time. We thus often refer to the motion of the electrons about the nucleus of the atom as the 'electron cloud.' Stated more precisely, the uncertainty in the momentum times the uncertainty in the position will always be larger than Planck's constant divided by 2pi. This effect is known as the *Heisenberg uncertainty principle*" (Lederman & Hill, p. 215). Further, "the very meaning of an electron, by itself, is not absolute. An electron is equivalent, by a gauge symmetry transformation, to a different electron with a different wavelength, together with the gauge field that resets the total momentum at its original value. The electron and the gauge field are effectively blended together to make one symmetrical entity" (p. 246).

[66] *Particle Physics for the Non-Physicist,* The Teaching Company.

[67] Silver, p. 233. Clearly the statistical nature of quantum mechanics has already played havoc with any simple application of this perspective to individual quantum events, but its relation to "classical" events remains less clear. Thus, quantum mechanics requires that causal determination be a statistical property of the structural situation, not a precise determination of individual events.

[68] I leave open at present the question whether consciousness might be able to exist in sufficiently complex nonbiological systems, though I do not see any reason in principle why that should not be possible.

[69] Hacker, p. 365.

[70] This is made quite explicit by Searle in his Teaching Company course on *The Philosophy of Mind.*

[71] As Edelman (p. 22) notes, "while synaptic change is essential for the function of memory, memory is a system property that also depends on specific neuro-anatomical connections."

[72] "Neuroscience can explain—indeed, specializes in explaining—how gross pathological deficiencies in the exercise of normal human capacities result from damage to the brain. So it can brilliantly explain why patients *cannot* behave as normal humans can in a multitude of different ways. In particular, it may explain why such patients are, in one way or another, incapable of acting rationally in certain respects" (Hacker, p. 365).

[73] Bhaskar, p. 127. "For instance, several studies, most notably those of Schacter, show that the same physiological state may be experienced in different ways and the same experience may be associated with different physiological states (so that for example stomach contractions and hunger may be out of phase)" (Bhaskar, p. 150n48).

[74] Understanding, of course, that this example is only used to suggest a similarity, the limits of which must be underscored by the fact that it would be a mistake to see the brain as primarily a computational mechanism. There are several reasons for this, as discussed, for example, by Edelman and Roger Penrose. While Penrose draws primarily upon Gödel's undecidability proof, Edelman offers a series of reasons drawn from the specificity of neuronal development. He observes that "from the very beginning of neuroanatomy, there are rich statistical variations in both cell movement and cell death. As a result, no two individuals, not even identical twins, possess the same anatomical patterns. . . . at a certain point [in early neuronal development] the control of neural connectivity and fate becomes epigenetic. . . . The result is a pattern of constancy and variation leading to highly individual networks. This is no way to build a computer, which must execute input algorithms or effective procedures according to a precise prearranged program and with no error in wiring. . . . [Further,] what would be lethal noise for a computer is in fact critical for the operation of higher-order brain functions" (Edelman, pp. 28–31).

[75] In criticizing the representational view of consciousness, Edelman elaborates on the neuroanatomical basis for there not being a one-to-one correlation between brain states and mental states: "Reflecting the effects of context and the associations of the various degenerate circuits capable of yielding a similar output. . . . There is no reason to assume that such a memory is representational. . . . Instead, it is more fruitfully looked on as a property of degenerate nonlinear interactions in a multidimensional network of neuronal groups. Such interactions allow a non-identical 'reliving' of a set of prior acts and events, yet there is often the illusion that one is recalling an event exactly as it happened" (Edelman, p. 52). ("Degeneracy is the ability of structurally different elements of a system to perform the same function or yield the same output" [p. 43]. "Degeneracy is a ubiquitous biological property. . . . Even identical twins who have similar immune responses to a foreign agent . . . do not generally use identical combinations of antibodies to react to that agent" [Edelman, p. 44].) "There are many ways in which individual neural circuits, synaptic populations, varying environmental signals, and previous history can lead to the same meaning" (Edelman, p. 105). The investigations of Wilder Penfield have, of course, revealed that stimulation of specific neurons could trigger neuronal activity that generated memories of past events.

[76] Bhaskar, p. 130. "The normal venue for the exercise of our cognitive powers is in situations of social interaction. . . . Of course, what are interpreted in communication are physical phenomena, such as sounds. But it cannot be maintained that there is a direct link, unmediated by interpretation, between the sound and the ensuing physical action. For, setting aside the obvious fact that it is the interpretation put upon the sound, not the sound itself, that is causally responsible for the resultant behavior, there is no one-to-one correlation between sounds and behavior. This is shown, at the very least, by the existence of, and the possibility of learning, different languages (or less macroscopically, usages) *or,* alternatively, forms of life (that is ways of behaving)" (Bhaskar, p. 135).

[77] "It is one thing to hold that a person would not believe, hope, fear, think, want, etc., whatever he does but for the fact that his brain is, in appropriate respects, functioning normally. It is quite another to hold that there are general bridge principles identifying a person's believing what he believes, etc., with a specific kind of neural state or condition. The former claim is an important platitude. The latter is misconceived. For there is no reason to suppose that two people may not, for example, believe the very same thing, yet the relevant (as yet unknown) neural structures in each person's brain be different. The criteria of identity for mental states, events and processes differ from the criteria of identity for neural states, events and processes" (Hacker, p. 358).

[78] Searle describes at least ten distinct characteristics of consciousness. They are:

- *Subjectivity:* qualitative feel, "what is it like?"
- *Unified stream or unity of consciousness:*
    - *horizontally*—continuity in time (vs. amnesia)
    - *vertically*—continuity of space (vs. Korsakov's syndrome)
- *Intentionality:* refers outward to the world
- *Mood*

- *Structured Gestalt:*
    - *forms—*tendency to produce coherent objects, even when the information is completely inadequate
    - *figure-ground.*
- *Center periphery or focus fringe:* James said “consciousness (should be attention) goes away from where it is not needed.”
- *Situatedness:* For example, a sense of where I am and where I’m going, the implicit “boundary conditions” of my location in space and time.
- *Aspects of familiarity*
- *Self-transcendence:* it always overflows its boundaries, pointing beyond itself
- *Pleasure-unpleasure:* always some sense of this

(It is *not true* that consciousness is always self-conscious; there is *no* faculty of introspection, no direct self-knowledge; and there is no (self-evident) certainty of knowledge.) (Searle, “*The Philosophy of Mind*,” The Teaching Company.)

[79] “Mind is more than consciousness, because it is the abiding even though changing background of which consciousness is the foreground. Mind changes slowly through the joint tuition of interest and circumstance. Consciousness is always in rapid change, for it marks the place where the formed disposition and the immediate situation touch and interact. It is the continuous readjustment of self and the world in experience. ‘Consciousness’ is the more acute and intense in the degree of the readjustments that are demanded, approaching the nil as the contact is frictionless and interaction fluid. It is turbid when meanings are undergoing reconstruction in an undetermined direction, and become clear as a decisive meaning emerges” (Dewey [2], pp. 265–266).

[80] In discussing “*The Ontology of Mental States*,” Laurie Paul argued that the reality of the knowledge gained from *having* the experience (of pain, for example) is something more and other than simply knowing its parameters, even though that reality is not accessible to objective scientific inquiry. Commenting on the now classic discussions by Thomas Nagel on “*What Is It Like To Be a Bat?*” and Frank Jackson on “*Black and White Mary*,” she argued that we need a phenomenology of the experience of being the *bearer* of the properties when one *has* an experience. There is an “ontological gap” between objective and subjective knowledge—the latter is grounded in the experience of being the bearer of the quality or property or capacity in question. (A talk given at the 2006 meeting of the Eastern Division of the American Philosophical Society.) This issue bears directly on our critique of a completely reductionist use of the medical model in addressing “mental illness,” addressed in Chapter 7.

[81] Though Dewey, in his now classic essay on “*The Reflex Arc Concept in Psychology*,” raised serious questions about any simple stimulus-response interpretation of organismic behavior, pointing to the crucial aspect of organismic set in determining the very meaning of the stimulus.

[82] “Neuroscientific explanations can typically explain how it is possible for creatures with such-and-such a brain to do the kinds of things they do. They can explain what neural connections must obtain and what neural activities must take place in order for it to be possible for the animal to possess and exercise the powers it naturally possesses. In the case of human beings in particular, neuroscience may aspire to explain the neural conditions for the possibility of the mastery of a language, the possession of which is itself a condition of the possibility of rationality in both thought and action. However, neuroscience cannot displace or undermine the explanatory force of the good reasons we sincerely give for our behaviour, or invalidate the justifications we give for rational behaviour. The rationality of behaviour that is motivated by good reasons is not given a deeper explanation by specifying the neural facts that make it possible for creatures such as us to act for such reasons. When we apprehend the propriety, adequacy or goodness of the reasons for which a person acted, then we fully understand why he did what he did” (Hacker, p. 364).

[83] Laughlin, p. 20.

[84] It is almost universally thought that Einstein lost that argument to Bohr, Heisenberg, and quantum indeterminacy. In the long run, however, I suspect that Einstein may prove to be right about the existence of “hidden variables,” though I suspect not in the deterministic fashion that, as a “Spinozist,” he envisioned. But that is clearly speculation on my part.

[85] Let me try to be as clear as possible. There are essentially two distinct but closely related issues that are at stake here, and one important consequence that is worth underscoring. The first issue concerns the

deductive model of argument first systematized by Aristotle. Sophisticated modern developments such as those involved with symbolic logic and multivariant analysis have done nothing to fundamentally modify the theoretical deductive frame by which there can be nothing in the conclusions that was not at least implicitly contained in the premises. The second issue concerns the Cartesian methodology, set forth most simply in his *Discourse on Method.* There he spells out the process for obtaining scientific truth by reducing "compounds" to their simple ("atomistic") components and then, at least conceptually, step-by-step reconstructing the original. The underlying assumption is that the compound can be fully understood because it is nothing more than the result of the workings of its constituent parts. My argument has sought to challenge both of these claims. In so doing, it has sought to undercut the reductive determinism that is their logical conclusion. But that should not be taken to claim that there is no place for causal determination. Quite the contrary. Such determination should be taken as operating at each emergent level in accord with the processes and powers appropriate for that level. In the cases of society and psychology that, of course, will often require consideration of the role of consciousness and choice.