NOTE: This paper was written as a talk given as the plenary address at the Proceedings of the Second World Congress on Synthesis of Science and Religion held in Calcutta, India. 1996. (R. Gomatan et al (Eds.), Bhakti Vedanta Institute, Oakland, CA.) Although not being a theist myself, I was asked nevertheless to speak from the point of view of an ecological "pantheist." To me that meant, to be honest, I would take Spinoza's pantheistic view as famously espoused by Einstein. Thus, wherever the word "God" appears please substitute "Nature."

CHAPTER 1: Cosmological Psychology: Making Room for Agents in Nature (24 pp)

Section Headings

Chapter 1: COSMOLOGICAL PSYCHOLOGY:
Making Room for Agents in Nature (24 pp.)

> Science cannot solve the ultimate mystery of Nature. And it is because in the last analysis we ourselves are part of the mystery we are trying to solve.
>
> –Max Planck

> The observed structure of the Universe is restricted by the fact that we are observing this structure; by the fact that, so to speak, the Universe is observing itself.
>
> —Barrow & Tipler

I. Introduction: The Universe as a Home for Life

Rarely do we worry about astronomical cataclysms that might doom our planet or our solar system. World famine, pandemic disease, nuclear holocaust, or industrial poisoning of our planet's atmosphere are more immediate threats. The old attitude that Nature is to be conquered or bent to our wills by industrial or technological might has not served us well. Perhaps, it is time that we change our attitudes.

Consequently, should we think of ourselves and other life forms as being at odds with an alien world, as being subjects and the world as an impersonal, threatening object against which we must compete? Or should we follow the advice of the philosopher and educator Martin Buber, and adopt instead a more personal and responsible attitude toward the Universe, what Buber called an *I-Thou* relationship (Buber, 1970)? Whether one believes in the *Me versus It* relationship or the *I and Thou* has important pragmatic consequences. For belief in the legitimacy of this personal relationship is more likely to foster in humankind a responsible and respectful attitude toward Nature by the believer.

With this more amicable attitude toward Nature, would we not be more likely to assume responsibility for how we treat our environments—the local manifestation of the Thou? Would we not depend more on ourselves to avoid polluting our home environment, or cleaning it up as we do? If we are consistent with this more responsible attitude, we might then work harder to avoid destructive activities, such as wars or industrial callousness that damage the Thou to whom we hold a personal responsibility.

We can choose to believe because such a choice is possible and defensible on pragmatic grounds alone; or we can come to believe it because a principled interpretation of contemporary scientific evidence allows, even warrants, preferring the *I-Thou* attitude over the *Me-It* stance. This paper will consider the reasons for this adjustment in scientific attitude being the most rational decision one might make.

Can there really be a scientific basis to this *I-Thou* relationship—one that is more than mere poetic metaphor? In what follows we consider, first, the case for its philosophical basis and, then, the case for its scientific basis.

Ecosystems and Ultra-Ecosystems

A system that is viable is one capable of behaviors and system functions that protect the system's integrity. Such a system has two components: the agency responsible for implementing the viable functions and an environment that can furnish whatever is needed to sustain viability. A system with these two components is said to be an *ecosystem* and the agency component is usually referred to as "living," a term that is synonymous with being viable and self-sustaining. That such systems exist is an evolutionary fact and one for which scientific cosmology must provide a reasonable account.

No doubt the Universe sustains this cosmic ecology through natural law; but the question arises as to whether it is itself some kind of special ecosystem, what might be called an *ultra-ecosystem*, that is, one whose agency entails itself as its supporting environment. The late general systems theorist, Robert Rosen (1991), defined living systems, as opposed to non-living ones, as having an *inner entailment* as their defining characteristic, namely, *being an X that entails a Y which, reciprocally, entails X*. Such a reciprocity or symmetry is the essential feature of the self-sustaining entailment between the agency and the environmental components in an ecosystem when the environment is different from the agent, and of an ultra-ecosystem when the environment and agent are dual functions of one and the same entity.

By contrast, *outer* entailments are those supported by external influences, such as initial conditions imposed from exophysical processes rather than by endophysical processes—as in the case of the unavoidable regress to ultimate initial conditions for law governed mechanical systems.

Thus, ultra-ecosystems satisfy a stronger condition than the symmetry relation of inner entailment. Where living systems require reciprocity between the agency and environmental components that qualify them as being an ecosystem, an absolutely isolated system must rely totally on itself as being both agency (i.e., that which acts) and environment (i.e., that which supports the acts). This is to say, the system's integrity is protected by a reflexive relationship to itself. This reflexivity means there is but one component with two functions rather than two separate components. This is not a new argument. This is the definition of the entanglement of two components (Shaw and Kinsella-Shaw, 2014).

Cosmologists since Spinoza have argued that the Universe, being all there is, can have no external influences but runs on its own self-contained resources. It must be governed by its self-authored laws and be both auto-catalytic and auto-regulatory. Initial conditions (or final conditions) count as external influences since they are complementary to dynamics and hence cannot be explained by dynamic (natural) laws alone. Dynamic laws (typically framed as differential equations) cannot be solved unless initial conditions are supplied to evaluate their parameters.

One way to escape this regress is to postulate a *circular* causality between the agency and environmental components in the form of an inner entailment, where, in a two component system consisting of *X* and *Y, if X initiates causal processes in Y, then Y must re-initiate causal processes in X, and vice-versa*. Here the initial conditions for the agency dynamics are imposed by the environment, while, reciprocally, the initial conditions for the environmental dynamics are imposed by the agent. Rosen's inner entailment solution works fine so long as the agency component of the system in question is not absolutely isolated but exists in a context which can serve as its environment. But what if the agency is isolated? If so, then another strategy is needed.

The alternative strategy and way out of the initial condition regress and the isolated agent dilemma is to replace the symmetry (reciprocity) strategy with a reflexivity strategy. This was the strategy proposed by the 18th century Dutch philosopher, Baruch Spinoza.

Spinoza postulated one absolute pantheistic system (Nature as God) with dual aspects—like two sides of the same coin—one that appeared as *agency* (mind) and the other as *environment* (matter). Leibniz, the great German philosopher and mathematician, agreed with this approach but developed it not as a monism but rather as a pluralism. He called this pluralistic theory a *monadology*, a theory of individuals (monads) with dual aspects but organized under hierarchical dominance relations (Leibniz, 1765/1982). Each monad reflects the behavior of the monad collective more or less perfectly.

Leibniz considered mind a chief monad whose inner life reflected better than other monads the external behavior of the monad collective. God is the ultimate chief monad, set at the top of this hierarchy, possessed with super-awareness which allowed it to reflect perfectly all and thereby exhibit the most intelligent (harmonious) behavior. Spinoza's collective was closed and perfected at this highest level without any need to evolve. Individual monads could however improve themselves by increasing their ability to reflect.

More than a century later, William James proposed a world of pure experience to avoid dualism (James, 1912/76). In the spirit of this philosophy of radical empiricism, James' followers and colleagues, soon after his death in 1910, formed a New Realists movement. The aim of this movement was twofold: First, to rid science and philosophy of the confusions and inconsistencies of Cartesian mind-body dualism, and, second, to avoid the mistakes of those metaphysical monisms (e.g., Hegel's and Bergson's) in which individual identities were dissolved by attempts at unification by resorption of differences. Unfortunately, they failed in their attempts to avoid crass dualism (e.g., mind-matter; subjective-objective dichotomies), on the one hand, and dissolution of the identity of things that should be preserved, on the other. In fact, they recognized that their approach was such an utter failure that they disbanded the movement after just a few years of effort (Harlow, 1931; Chan and Shaw, 19??).

A Scientific Foundation?

A scientific hypothesis that seems to avoid these twin defects of regress and dilemma has recently been proposed (Gibbons & Hawking, 1977). Here the theorists postulate a boundary free, "laws only" cosmology—where all constraints are made intrinsic to the system (by a controversial use of complex numbers to Euclidianize space-time). In this way, the Universe is represented as an absolutely isolated system, with nothing beyond its borders—no space, no time, and no matter or energy. One might argue that this laws-only approach poses a stronger condition than Rosen's inner entailment idea. If the Universe is itself an all-inclusive ecosystem, then it is an *ultra*-ecosystem where, being unique in the sense that, *X entails Y and Y entails X as automorphic functions of some single entity Z.*

More modest ecosystems, such as terrestrial ones, may exist only as conditionally isolated systems. If the conditions that support the ecosystem are intrinsic to the system itself, then the system is, relatively speaking, an ultra-ecosystem—at least temporarily, so long as its conditional isolation survives assault from the external environment-at-large. This is the nature of closed ecosystems (rare) or the interlocking resource (e.g., food) chain among ecosystems with intersecting niches (more common).

To be an ultra-ecosystem, an ecosystem must be self-sufficient, self-sustaining, self-motivating, and self-organizing. Unlike the Universe as a whole, most ecosystems are dependent on external resources. On occasions however an ordinary ecosystem may be temporally autonomous and qualify as being conservative, or quasi-ultra. Let's consider a case where this may be so.

The bioenergetic study of ecosystems addresses the issues of energy and matter exchange between the environmental and agency components. If what the agency needs is furnished adequately by its environment, then the system is functionally and structurally closed and conservative—so long as no perturbation from the outside world intrudes. In an uncertain environment an agent may fail to make appropriate adjustments to cancel the untoward influence. If however the agent can learn to re-equilibrate so as to cancel the perturbation, then the ecosystem can have its autonomy restored, at least until the next perturbation intrudes.

To be able to learn entails that the agency has processes traditionally called "psychological": It must be able to detect information specific to the perturbation, and do so in a manner that scales to and directs its control processes toward the goal of re-equilibration. This requirement clearly transcends bioenergetics by demanding that the system be capable of information detection and control coordinated to direct actions toward an intended goal. Such systems are then said to exhibit *intentional dynamics* (Shaw and Kinsella-Shaw, 1988; Shaw, Kugler, and Kinsella-Shaw, 1990; Shaw, ??).

Psychological ecosystems may also be conditionally isolated: If the agents' environments furnish them the information, they need to support their goal-directed activities, and they have the means to control and sustain such activities, then the agent is deemed viable and self-sustaining—a veritable functional ultra-ecosystem. Similar limitations however hold as in the case of the ecosystem's bioenergetic processes.

Ultra-ecosystems, whether absolute or conditional, all have one thing in common; they are capable of exhibiting intentional dynamics. Intentional dynamics refers to the competence of the agent to realize goal-directed activities. The question to be addressed is whether contemporary physical theories provide foundations for ecosystems, say, as a kind of continual atavistic prototyping, or whether they only occur through emergence late in cosmological evolution (Shaw, in press). If so, then cosmological psychology will have as much priority in the compass of Nature as cosmological physics.

Let's take a closer look at what psychology at the ecological scale means.

Ecological Psychology

Consider the words of James J. Gibson, the founder of ecological psychology:

> Awareness of the persisting and changing environment (perception) is concurrent with the complementary awareness of the persisting and changing self . . . (Gibson, 1978. Cited in Reed & Jones, 1982, p. 418).

For Gibson there is a way to blend psychology and physics into one world view. He, like William James, recognized that the old categories of mind and matter were misleading and led to what the philosopher Alfred North Whitehead (1978) called "the bifurcation of Nature "—the very problem that the New Realists wanted to avoid. Gibson's insight was that this division in Nature might be avoided by reformulating the relationship of value to meaning. Meaning and value are essentially omitted from ordinary physics. Not so in ecological physics because it is closely wedded to psychology. Gibson (1971) explains it this way:

> What a thing is and what it means are not separate, the former being physical and the latter mental, as we are accustomed to believe. . . . The perception of what a thing is and the perception of what it means are not separate, either (Cited in Reed & Jones, 1982, p. 408).

To hold his psychology apart from the mind-matter distinction, a dead-end concept that he felt halts scientific progress toward the larger truth, he coined a new word "affordances." Affordances are both what the world means to living creatures and what it furnishes them as opportunities for action—either for good or ill. Are affordances mental or material? They are neither or both as Gibson points out:

> The notion of affordances implies a new theory of meaning and a new way of bridging the gap between mind and matter. To say that an affordance is meaningful is not to say that it is "mental." To say it is "physical" is not to imply that it is meaningless. The dualism of mental vs. physical ceases to be compulsory. One does not have to embrace materialism in order to recognize the necessity of physical stimuli for perception (cited in Reed & Jones, 1982, p 409)

He goes on to point out an important fact about affordances of the environment that seems quite paradoxical:

> They refer to properties of the world that are objective, real, and physical, and therefore seem quite unlike values and meanings; but they also refer to the

> subjective, phenomenal, and mental, and therefore seem quite likes values and meaning.

How is this paradoxical nature of affordances to be resolved? By a kind of Spinozoistic double aspectism, according to Gibson (1979):

> But, actually, an affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer (p. 129).

If ecological psychology is embraced, then ecological physics follows immediately as the other side of the same coin. Later we shall return to the claim that ecological physics is the most reasonable place to search for the scientific foundations for agency as needed for autonomous systems like ecosystems, and those that approximate, under certain conditions, ultra-ecosystems.

Before taking up this issue, however, we must determine if ecological physics, which allows autonomous agents, is consistent with traditional physics. It would defeat our purpose if our account of viable ecosystems that exhibit intentional dynamics were unscientific. But let us be clear on what is demanded for such a theory: Ecological physics does not have to be subsumed under traditional physics, but it must not contradict its facts or principles since they are the best science has had to offer. We shall therefore seek weaknesses in the walls of traditional theories of physics where they may be more flexible than mechanists and determinists would like to admit.

II. Do the Laws of Mechanics Leave Room for Agents?

Nineteenth century mechanistic physics had as its goal a perspective-free view of Nature. Where psychology might deign to look at individual differences over agent perspectives on Nature due to genetic constitution, learning, or degree of intelligent insight, the aim of reductionistic physics was to democratize all such differences—to give as it were a God's eye view of Nature under the strict determinism of Newton's laws. No psychological attributes matter if an agent is reduced to a mass pushed around by external forces. Problems arise for reductionistic physics however when dynamic phenomena are formulated under Hamilton's integral principle of stationary action rather than Newton's differential laws.

Hamilton took a different tactic from Newton. Newton's laws specify the sequence of instantaneous force vectors needed, at each successive infinitesimal step, to push a particle down its observed trajectory. By contrast, Hamilton used a different but formally equivalent tactic to explain dynamic phenomena. What if at each such infinitesimal step no directed force (a vector) is specified; rather it is left to the particle to select from all possible directions that special one which leads it to do the least work over all future times. How the particle is able to do this intelligently is left unexplained; only the criterion by which a particle must choose is given, namely: *Select the next step always so that the work in producing the path is minimized!* But how might a particle make such choices?

One way entails a solution strategy. The particle would have to conduct "off-line" simulation of all the paths to be compared, develop and apply an algorithm to compare all the paths in terms of their total action, and then assign action weights to each path proportional to the work required over time for the particle to take that path; finally, the particle must ignore all paths that involve the greater action, until a final path with minimum action is found. Only then can the particle continue on its way.

Here are the problems that make this solution strategy unacceptable: In order for the particle to be so informed of the proper choice to make, all of these path comparisons and path eliminations will either have to be done instantaneously or take place outside the scope of real time, otherwise the particle is kept hanging around with its dynamics interrupted by an acausal delay. Such interruptions however are not allowed in causal dynamics: Causal laws require that the effects follow immediately upon their causes, without delay, otherwise the dynamic path becomes disconnected. One serious repercussion of the particle's forward progress being stalled is that the conservations of energy and momentum are violated.

Conservation principles tell dynamics which paths among the arbitrarily possible paths are physically proper. For instance, a free particle being without constraint can in principle proceed in any direction whatsoever. A particle in a field is allowed to follow only paths of a certain shape—the particular one being selected by initial conditions. A particle thrown into a gravitational field is allowed to follow only paths with a parabolic shape, with the specific parabola being selected by the initial velocity of the particle. Even when the initial conditions are left unspecified, the particle still is restricted by the field constraint to follow only some member of the family of parabolas. Not to do so would violate the conservation laws—the gate-keepers for path selection.

But more to the point: What kind of strange particles has Nature evolved that are capable of conforming to Hamilton's principle? For this principle assumes that the particle is capable of testing and eliminating from an infinite number of paths just that one which has the action preferred. To be physical, the choice made must conform to the conservation principles. Does this mean then that the particle adopts a policy—an intention—to be physical rather than nonphysical?

In Chapter VII of *Science and Hypothesis*, and echoed by many others ever since, Poincare (1905/1952) remarked, with great consternation, that the assumption of the principle of least action by which one passes from force-based mechanics to a potential (energy)-based mechanics involves an "offense to the mind:"

> The very enunciation of the principle of least action is objectionable. To move from one point to another, a material molecule, acted upon by no force, but compelled to move on a surface, will take as its path the geodesic line, i. e., the shortest path. This molecule seems to know the point to which we want to take it, to foresee the time it will take to reach it by such a path, and to know how to choose the most convenient path. The enunciation of the principle presents it [the particle] to us, so to speak, as a living and free entity. It is clear that it would be better to replace it by a less objectionable enunciation, one in which, as philosophers would say, final effects do not seem to be substituted for acting causes (pp. 128-129).

Under this interpretation, Hamilton's principle imputes to the particle an agency which seems to lie outside of dynamic law but within the purview of conservation law. Indeed, if one replaces the word 'molecule' with the word 'actor', then no better description of a system with intentional dynamics is to be found. But here it seems inappropriate, for it amounts to anthropomorphizing inanimate particles. The danger that the variational approach to mechanics might tempt theorists to anthropomorphize particles is still recognized today.

Like Poincare', who thought that Hamilton's principle was "an offense to the mind!" because it promoted such anthropomorphizing of inanimate particles, so too have other physicists expressed similar perplexity as to how Hamilton's stationary (least) action principle could work. Feynman expresses his perplexity rather colorfully as follows:

> It isn't that a particle takes the path of least action but that it smells all the paths in the neighborhood and *chooses* the one that has the least action by a method analogous to the one by which light chose the shortest time (Feynman, Leighton, & Sands, 1968; **2**, 19-9. Emphasis added.)

A more recent quote shows that Poincare's concern has not abated with time:

> The mechanism by which the particle selects the physical trajectory of stationary action is not at all clear. The initial velocity is not given, so that the particle will not 'know' in which direction to start off and how fast to go. It is not clear how the particle can 'feel out' all trajectories and 'choose' the stationary one. It should be kept in mind that classical physics does not recognize any path other than the stationary path. Thus, out of a whole set of 'nonphysical' paths, introduced a priori, the classical principle of stationary action selects a unique physical trajectory through some mechanism which is not readily apparent" (Narlikar & Padmanabhan, 1986; p.12).

Since mechanistic explanations of particle motion, such as Newton's, and the 'choice' explanation by Hamilton, are mathematically equivalent, then we are free to choose that view which is most consistent with a complete cosmological theory. A complete cosmological theory must accommodate itself to the actuality of both live and dead matter, of both insensate and sentient matter. Why then should we not choose Hamilton's explanation so that prototyping of more sophisticated material system might have evolved from the 'big bang' origins of the universe? In this way, psychological systems would have origins as deep into cosmological beginnings as physical ones. This may seem a bizarre assumption but it is not illogical and actually presages certain claims from quantum physics to be reviewed later.

III. Do the Laws of Thermodynamics Leave Room for Agents?

Hamilton's view may have its problems but so does Newton's. A vexing problem for the Newtonian theorist is the unavoidable regress entailed. The dynamics of external forces that direct the particle down the least action path leads ultimately to the initial conditions from which such forces inherit their directionality. But initial conditions are not part of the dynamic solution but are a prior external influence assumed by it. Mechanism is a philosophy consistent with Aristotle's regress from the currently moved, through an unbroken chain of intermediate movers, coming to rest finally in some kind of Unmoved Mover.

Regarding this regressive mechanistic explanation of dynamics, Pierre Laplace, one of the fathers of modern mechanistic physics observed: If the present state of the universe was exactly similar to the anterior state which has produced it, it would give birth in its turn to a similar state: The success of these states would then be eternal. Furthermore, given the laws, the only obstacle to complete knowledge of the world is ignorance of initial conditions (Laplace, 1814).

In such a view, nothing creative is allowed beyond that which is introduced at the very beginning. All value, meaning, or purpose we associate with life forms, must be inserted *sui generis*. Thus, the Prime Mover acts as God-the-Designer who sets all the initial conditions of the universe so that, like a wound-up toy, it simply runs down to entropic disorder as demanded by the second law of thermodynamics.

If, however, in the course of cosmological evolution, determinism is not absolute and a degree of indeterminism is allowed, so physical process may require a statistical physics for its explanation. Such was the fundamental assumption of the science of thermodynamics. The random factor introduces is an additional degree of freedom in physical process. Chance permits value and meaning to arise in a way that requires no God-like intervention. More than a century ago Charles Sanders Peirce (dates?), the friend of William James and co-founder of pragmatic philosophy, explained how such emergence of value and meaning might occur in spite of the hold of thermodynamic law:

> But although no force can counteract this tendency, chance may and will have the opposite influence. Force is in the long run dissipative; chance is in the long run concentrative. The dissipation of energy by the regular laws of is by these very laws accompanied by circumstances more and more favorable to its concentration by chance. There must therefore be a point at which the two tendencies are balanced and that is no doubt the actual condition of the whole universe at the present time (C. S. Peirce, 1892, pp. 321-337.).

The hegemony of thermodynamic law is thus not absolute but may leave negentropic order in its wake. Could such pockets of order not be the fertile ground in which the intentional agency of ecosystems arises?

IV. Do the Laws of Quantum Physics Leave Room for Agents?

Consider the quote from the eminent scientist, Max Planck, used as the caption to the paper (Barrow & Tipler, 1986). Planck, one of the founders of quantum physics at the beginning of last century, expresses an extreme, anti-positivistic form of scientific pessimism. He implies that conscious life, by virtue of being aware of itself and its surroundings has somehow disqualified itself from any hope of understanding the Nature it is part of. Without explanation, he implies that our subjectivism somehow limits our ability to understand. Is Planck's pessimism warranted? Or, if so, might it be circumvented?

If Planck is correct, then we may not understand the universe as we participate in it, but only objectively, exclusive of our participation. By contrast, modern quantum theory argues that we live in a participatory universe, one that we cannot understand unless we *do* participate in it. The form of that anticipation, some physicists argue, is to collapse a quantum universe comprising an indefinite number of superposed states into an existentially unique state—the world as it appears to us. This difference between the uncollapsed, indefinite quantum world and the collapsed, definite world of classical physics deserves further attention.

Does the moon exist just because a mouse looks at it? Einstein was fond of asking his quantum theorist friends this question (Kaku, 1995). Neither the moon nor the mouse (for that matter) exists as simple objects. Rather according to one interpretation of quantum theory, all objects (Einstein and yourself included) exist as a superposition of all the possible states they can be in. To have a definite existence means to be in a definite state, that is, for the wave function that describes all possible superposed states to collapse in a certain way. What might make it collapse?

The Nobel laureate, Eugene P. Wigner, argued that the wave function collapses into a unique state upon being perceived (Wigner, 1964); but not wishing to let just any perceiver determine the state of all the objects in the universe, and hence of the universe itself, he proposed the following solution: If we assume that we live in the universe of classical physics, where Newton's laws hold, then it is always in a definite state and is never in an indefinite superposition of states. According to Wigner, this implies that all parts of the universe must be in the process of being continually experienced at all times. It is unreasonable to think that any human observer, or even all of mankind, could be responsible for such distributed perceptions as to render the universe definite.

Therefore, following this line of reasoning, there must be some kind of cosmic consciousness in the Universe, God if you like, under whose awareness the wave function of the Universe collapses into a definite state—a collective state which includes us and all of that about which we are aware! This is a solution that would have made Bishop Berkeley, the British subjective idealist, proud. He asked, you will recall, whether a falling tree would make a noise if no one was around to hear it (Berkeley, 1709/1954). Under the quantum interpretation of physical reality, one might similarly ask if any event or object is definite if no one is around to perceive it.

Under the Wigner-Berkeley view, not only is agency allowed by quantum physics, it is required if we are to explain the appearance of the world as we know it. Agents must exist as 'collapsers' of wave functions! Psychology seems therefore as indispensable to cosmology as is physics.

V. Do the Laws of Relativistic Physics Leave Room for Agents?

When asked did he believe in God, Einstein (1929) replied: "I believe in Spinoza's God who reveals himself in the harmony of all that exists, but not in a God who concerns himself with the fate and actions of human beings" (p. 147). Of all major philosophers, Bertrand Russell, the Nobel Laureate, said the 17th century philosopher Spinoza was the most noble and lovable of all great philosophers (Russell, 1945). Let's take a moment to review the ideas that so enticed Einstein.

Despite being damned by both the Christian and Jewish communities in Holland for his presumed heretical ideas, despite having to work ten to twelve hours a day as a lens grinder, despite failing health from dust infected lungs—a hazard of his trade, the bachelor Spinoza still managed to remain a courageous, industrious, and objective intellectual, with a gentle and kind nature, qualities which made him beloved by both friends and neighbors. Overcoming obstacles that might have embittered and discouraged a person of less character, he managed to produce a grand and logically coherent philosophical system. The sole aim of this system was to help make life easier through enlightened understanding of God's intimate place in the world as natural law. Perhaps, it was the quality of the man as much as the profundity of his philosophy that attracted Einstein to Spinoza.

As mentioned earlier, Spinoza was a pantheist, and thus believed that God and Nature were one. Because Nature is all there is, there can be no external influences that can control or qualify Nature's powers. Thus Nature, is the only true ultra-ecosystem and as such has but one restriction: whatever action it takes is free from constraint; it must obey only its own law.

Can Nature change in the sense that its law evolves? Evolves toward what? The target state toward which it evolves must be within itself. If so, then would it not already have evolved to fulfill its nature? Thus for Spinoza, Nature cannot really change but only appears to do so from our limited perspectives. Free will is an illusion, for being part of Nature, we cannot have agency that will disrupt the flow of Nature's autonomous course.

Nothing we do can violate the law and all that we do is dictated by that law. According to Spinoza, knowledge is the understanding of this fact and ignorance its denial. If Einstein's God was Spinoza's Nature, then can Einstein's world be any different? Let's follow this line of reasoning to see.

Each location in the Universe can be assigned a perspective or frame of reference. From a generalization of his Principle of Relativity, Einstein developed the idea that the laws of Nature must look the same in every frame of reference. Mathematicians labeled this the *general covariance principle* to emphasize Einstein's belief that laws must take the form of tensors that apply invariantly over all coordinate systems.

Properties that make one frame distinct from another frame are nullified under tensor invariant laws—that is, general covariance. For this reason, individuality is lost and no observer's perspective is to be preferred over that of another. Even more strongly one might say, the apparent existence of distinct perspective frames is but an artifact of ignoring the law that there is covariance over frames. Such covariance makes the frames disappear from scientific contention. Thus, Spinoza's idea that our individuality arises from ignorance of the laws is accurately reflected in Einstein's general covariance.

To hold to the idea of the reality of such frames is to commit a 19th century, pre-relativistic mistake. It follows of course that if frames are not individuated, then our personal perspectives ultimately must be seen as having no reality within the Einstein-Spinoza Universe but are mere appearances. Our participation then cannot truly influence the course of the Universe, not because it is so slight due to our diminutive scale, but because our effects as agents are no different from other "fictive" forces (e.g., centrifugal, inertial, Coriolis 'forces') which also disappear under tensorial treatment expressing covariance over frames.

Following this line of reasoning early Einstein, like Spinoza, arrived at the same conclusion; namely, the Universe must already contain all that is or ever will be. It is therefore stationary, else the great conservation laws would be violated by either creation or destruction of energy and momentum. To insure against such violations, Einstein inserted a cosmological constant into his equations to cancel any such change—a tactic that he later came to believe was the greatest blunder of his life.

Ironically, many cosmological theorists have now come to believe that Einstein's "blunder" was really a stroke of genius (Goldsmith, 1995). By treating the so-called "cosmological constant" as a variable, it can be manipulated to describe the Universe as either contracting or expanding and not just as stationary.

Intentional agency is needed when a system (e.g., an ecosystem) must exploit the laws of Nature so as to direct the system toward achieving a goal required for it to remain viable. This requires specificity of boundary conditions, individuality of purpose, and focus of control, none of which can be expressed under general covariance. Yet, so far, we have considered how the individuality required for such agency is invisible in general relativity under tensorial expression of natural law. There is however an underspecified aspect of general relativity by which intentional agency might wind its way into Nature.

For a property of natural processes to be invisible under general covariance does not mean that it does not exist. It simply means that it may be hard to capture by our best scientific sieves. Intentional agency could be intrinsic to Nature but missed by our scientific scrutiny which has been corrupted by too much of the 19th century mechanistic attitude carrying over into 20th century physics. Here at the start of the new millennium, we should make a concerted effort to rid our science of this inherent teleophobism—a fear of humanizing science and a timidity in taking Nature to be the *Thou* to our *I*.

Through a proper interpretation of Hamilton's stationary action principle and the so-called anthropic principle, we now have a legitimate scientific alternative to crass mechanism.

VI. Ecological Physics, Intentional Dynamics, and the Laws of Agency

As discussed earlier, ecological psychology entails ecological physics when physical properties are reformulated functionally as affordances at the ecological scale. Affordances, you will recall, are opportunities for action, and express, dually, both what might be done by an agent and what physical properties must remain invariant if such intended actions are to be realized. (For example, one perceives water both as being drinkable and as being a transparent, odorless liquid with a potable temperature; or an abode is seen as providing shelter and as having a certain size, strength, and integrity against the weather or marauding predators).

In this way, physics and psychology are given a functional connection through biology—at least when biological functions are framed as *effectivities*—the means by which affordance goals might be realized. (Such as having the neuro-muscular control enabling one to lift the glass of water to ones lips, sip, and swallow.)

Ecological psychology depends on ecological physics for its theory of environmental affordances and agent effectivities. Indeed, the environment, viewed from the point-of-view of the agent, is a dynamic affordance structure, while the agent, as viewed from the point-of-view of the environment, is a dynamic system of effectivities. Construed in this way, the functional descriptions of the environment entail the meaning (information) furnished the agent regarding potential goals and support for opportunities for action. At the ecological scale, this constitutes a theory of the *Thou*, a theory of a hospitable environment.

Correspondingly, the functional descriptions of the agent entail the manner (control) in which the agent pursues intended goals. At the ecological scale, this constitutes a theory of the *I*, a theory of competent agents. We have coined the term 'intentional dynamics' to refer to the process by which a fit is obtained between the environment's affordances and the organism's effectivities—a theory of how the *I* successfully confronts the *Thou*.

To realize an affordance goal (e.g., drink the water or enter the shelter) by means of properly controlled behaviors (effectivities), is for the agent to exhibit intentional dynamics of a certain sort. Intentional dynamics can be described as pursuing a path of action which, in the spirit of Hamilton's principle, might be selected from a set of alternative paths according to whether it *better* satisfies some goal than the other paths. The term 'better' here refers to pragmatic satisfaction within acceptable tolerance limits rather than optimality in a purely variational sense.

Intentional dynamics can be viewed as being necessary if the spirit of Hamilton's principle is defensible across the board, so that agency can be legitimately attributed to all entities in Nature, from minute particles to ecosystems. Next, we consider an argument that makes the idea of intentionality as a fundamental aspect of Nature scientifically palatable.

The Field Concept and Acausal Interactions

According to Newton's laws of gravitational attraction, two objects separated by empty space can causally interact with an attractive force directly proportional to their masses and inversely proportional to the square of the distance separating their centers. Nothing is said here about what happens in the empty space between the masses. Newton's gravitational attraction required "action-at-a-distance," an idea that did not make him happy since he favored forces that acted by mechanical contact.

By the middle of the 19th century, this idea of a mysterious *action-at-a-distance* was supplanted by the idea of a field potential that filled the space between the objects and provided mediating support for their interaction. The model for this idea was the electromagnetic field potential. Scientific history was irrevocably changed when Einstein proposed that the intervening "potential" was nothing other than the fabric of space-time itself.

Einstein admonished other physicists to adopt the belief that the field potential was to be treated as *real* and not just as a convenient mathematical fiction (Einstein & Enfeld, 1936/1971). The field concept helps restore causality in the case of Newton's mysterious attractive force but does nothing to exclude the possible role of intentionality. For the Einstein field equations can be derived from a generalization of Hamilton's action principle, as discovered by the German mathematician, David Hilbert. By using the action principle and hints from Einstein himself, Hilbert (???) discovered independently the final form of Einstein's field equations a few days before Einstein did. Max Planck believed the action formulation was superior to more mechanistic accounts because it expressed the laws of physics in a relativistic manner. The action is a scalar, and so its value is independent of any coordinate system. Planck also favored the action formulation because it plays a fundamental role in the quantum physics he helped originate.

The Mischief Caused by Field Theory

Certain problems however are introduced by the field concept as part of its baggage. For instance, particles in an environmental field are surrounded by their own field—called *the self-field*. Unfortunately, any attempt to integrate the particle's field with the environmental field leads to non-renormalizable infinities—a disastrous theoretical outcome. To avoid this critical problem, the self-field is typically ignored.

Another problem introduced by postulating fields to protect causality is the strange case of the vector potential. A moving charge in a wire will induce a flux in another wire loop which encircles it—even when great pains are taken to shield the wire loop from the first wire's field. In other words, a flux in one wire transmits an effect to another wire even when *no field exists to mediate a causal connection!* The concept of vector potential was introduced as a ghostly (nonphysical) field to give a semblance of continuity between the two wires that might support a causal connection.

There are many other anomalies that might be mentioned that arise when the field construct is introduced to rid physics of the intentionality smuggled in by Hamilton's principle. One especially curious one is that a black hole is predicted by relativistic field theory to give an anticipatory response to the approach of a particle before it is to be swallowed (Shaw and Kinsella-Shaw, 2014). No causal basis can be given to explain such an advanced reaction; however, a kind of intentional Hamiltonian principle works nicely to explain the effect. Although field theory was introduced to get rid of intentionality, such anomalies that it creates make the medicine seem as bad as the disease it was meant to cure. But is the field theoretic cure actually required?

Beyond Fields: Feynman's Sum-over-Histories

Intentionality was fundamental to Richard Feynman's views on electrodynamics which he developed with his teacher John Wheeler when he was a graduate student. Instead of explaining how one particle interacts with other particles by placing an electromagnetic field around them to act as a causal mediator, they showed mathematically that the behavior of a particle at the current moment depends only on what other particles did in the past *and* might do in the future (known as a *retarded* and *advanced* potential solution); hence the way a particle acts today anticipates the behaviors of future particles. Since particle behavior is explained by particle behavior, without the need for field potentials, the field construct is rendered superfluous.

> The action principle formulation of Wheeler-Feynman electrodynamics is conceptually simpler than the usual field-and-particle formulation, in that it does not need to introduce the notion of an electromagnetic field—electrodynamics is due to the direct action of the particles on themselves. In the Wheeler-Feynman picture, the electromagnetic field is not a real physical entity, but just a book-keeping device constructed to avoid having to talk about the particles teleologically (Barrow & Tipler, 1988, pp. 151-152).

The Wheeler-Feynman action formulation unfortunately broke no new experimental ground but did lead Feynman' to his crowning work: a new action principle method called the "sum-over-histories" approach (Feynman & Hibbs, 1965). Unlike the earlier formulation, Feynman's new method has motivated both theoretical and experimental support for gauge theories. All of contemporary particle physics can be formulated in terms of gauge theories.

Furthermore, since Feynman's new action principle method, like Hamilton's, supports the intentionality interpretation of physics, it is thus made fundamental to our current conception of Nature. Alternative methods have been formulated for particle physics to exclude the intentionality inherent in Feynman's approach but to no avail. The authors of the competing method admit that they themselves do not find their alternatives as useful or as heuristically appealing.

Taking Stock

What should we make of all this? Minimally, it suggests that science may have been too hasty in throwing out the intentional idiom; it may deserve a place in science more secure than old fashion mechanism or other agency-free idioms. Does this mean we should tolerate anthropomorphic descriptions of particles?

Or, better, perhaps we should accept the possibility that intentional agency is as fundamental to Nature as causal connection. The two may be distinct dual aspects of some underlying reality whose ultimate nature still eludes us. If so, then it would be just as legitimate to refer to *causes as being intended* as to *intentions as being caused*. The former calls for a theory of how intentions can be the initial conditions of causal dynamics (hence intentional dynamics), while the latter calls for a theory of how intentions can be final conditions produced by causal dynamics (hence dynamics of intentions).

Such a circular logic is tantamount to the inner entailments essential to ecosystems and have been postulated as perceiving-acting cycles or information-control loops in ecological psychology (Gibson, 1979).

The Anthropic Principle

As a home for life, the cosmic hospitality offered has been given a name: *the anthropic principle*. Cosmological psychology originates from the study of this principle, and the investigation of the theoretical constraints it places on physicists, biologists, and psychologists in explaining how the evolution of mind fits with the evolution of matter into life. Consider one of many arguments for the validity and usefulness of the anthropic principle.

We have no trouble accepting the claim that houses, as well as the furniture, clothes, crockery, appliances, books, etc. that fill them, are body-scaled, that is, designed to fit human dimensions. Indeed, this is so because anthropometric scales were purposively used to determine their sizes—just as canine and aviary scales are used to design doghouses and birdhouses, respectively (Shaw, Flascher, & Kadar,??).

On the other hand, to say that the Universe was designed to fit life on earth, rather than that the design of life on earth was a result of aimless causal processes, seems to put the cart before the horse, so to speak. Where anthopometrics is a method developed for the expressed purpose of designing furniture and other items to fit their human users, cosmological evolution surely was not selected to be a method for designing the Universe, the solar system, the earth, its geology, weather, flora and fauna to suit our being here. Life accommodates to circumstances in the physical Universe; the Universe *surely* does not accommodate to our presence. Or, does it? Surprising as it may seem, this is just what the anthropic principle asserts.

The primary ingredients cooked in the primordial furnace of the Big Bang were hydrogen and helium gases. Living systems are built up from elements more complex than hydrogen and helium gases but which had to be fused out of them. The building blocks for life as we know it, namely, carbon, oxygen, nitrogen, and phosphorous, had to be synthesized from hydrogen and helium but over a much longer time than the period of the Big Bang allowed. The additional requisite cooking had to be slower and at more moderate temperatures.

These more favorable conditions were satisfied by the creation of stars. Within these stellar interiors the exothermic nuclear reactions took place needed to fuse hydrogen and helium into the larger molecules—the raw materials from which giant molecules needed for life could be synthesized. Eons later, as the stars began to grow old, many died spectacular deaths—becoming supernovae. These exploding stars disperse these materials throughout the Universe, eventually becoming incorporated into planets, and finally ourselves.

Two dimensions of the Universe were set by the fact that life was created: For there to be sufficient time for human life to evolve, the Universe must have expanded for at least ten billions years, which means it now must extend over a radius of ten billion light years. It seems an inescapable conclusion that anthropometry does indeed have implications for cosmic measurement. Such implications have been named the *weak* Anthropic Principle.

In their classic book on the topic, Barrow & Tipler (1988) explain how this principle, when treated as a cosmic selection principle, deepens our scientific understanding of how the inorganic and the organic worlds are mutually dependent, and makes clear the intimate connection between the large and small-scale structure of the Universe.

> It enables us to elucidate the interconnection that exist between laws and structures of Nature to gain new insight into the chain of universal properties required to permit life. The realization that the possibility of biological evolution is strongly dependent upon the global structure of the Universe is truly surprising and perhaps provokes us to consider that the existence of life may be no more, but no less, remarkable than the existence of the Universe itself (p. 4).

The Anthropic Principle expresses the original inner-entailment of an ultra-ecosystem: "the observed structure of the Universe is restricted by the fact that we are observing this structure; by the fact that, so to speak, the Universe is observing itself" (Barrow & Tipler, 1988. p. 4).

There is no excuse for science not to stretch its boundaries to incorporate mind, matter, and life as three phases of the same underlying reality. The future of the science of cosmology will be furthered significantly when psychology, biology, and physics are incorporated as equal partners under a true ecological cosmology—an ultra-ecosystem as home for both the *I* and *Thou*. By restoring intentionality to our conception of the

Universe, the 'dimension of depth' lost when mechanism dehumanized Nature is again found.

References

Barrow, J. & Tipler, F. (1986). *The anthropic cosmological principle.* Oxford: Oxford University Press.

Berkeley, G. (1709/1954). An essay toward a new theory of vision. In *Berkeley: A new theory of vision and other writings*. London: Dent.

Buber, M. (1970). *I and Thou*. New York: Scribners.

Chan, T. C. & Shaw, R. (1996). What is ecological psychology? *Psychologia: An International Journal of Psychology in the Orient* , **39**, 1, March, 1-16.

Einstein, A (1929). Telegram to a Jewish newspaper, Einstein archive 33-272. Cited in Calaprice, A. (Ed.) (1996). *The quotable Einstein*. Princeton, NJ: Princeton University Press.

Einstein, A. & Enfeld, L. (1936/1971). *The evolution of physics.* Cambridge: Cambridge University Press.

Feynman, R. P. & Hibbs, A. R. (1965). *Quantum mechanics and path integrals*. New York: McGraw-Hill.

Feynman, R. P., Leighton, R. B. & Sands, M. (1968); *The Feynman lectures on physics*. vol.2, Reading, MASS: Allison-Wesley

Gibbons, G. W. & Hawking, S. W. (1977). *Phys. Rev.* D, **15**, 2738.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Boston: Houghton-Mifflin.

Goldsmith, D. (1995) *Einstein's greatest blunder: The cosmological constant and other fudge factors in the physics of the universe.* Cambridge, MASS: Harvard University Press.

Harlow, V. E. (1931). *A bibliography and genetic study of American realism.* Oklahoma City, OK: Harlow Publishing

Hartle, J. & Hawking, S. W. (1963). *Phys.Rev. D*, **28**, 2906.

James, W. (1912/1976). *Essays in radical empiricism*. Cambridge, MASS: Harvard University Press.

Kaku, M. (1995). *Hyperspace: A scientific odyssey through the 10th dimension*. Oxford: Oxford University Press.

Laplace, P. S. de (1812/1902). Philosophical essays on probabilities. Discussed in *Encycl. of. Phil*., **4**, 391-393. New York: McMillan

Leibniz, G. W. (1765/1982). *New essays on human understanding*. Cambridge MASS: Harvard University Press.

Narlikar, J. V. & Padmanabhan, T. (1986). *Gravity, gauge theories and quantum cosmology*. Dordrecht, Netherlands: D. Reidel

Peirce, C. S., *The Monist*, **2**, 1892, pp. 321-337.
Poincare (1905/1952) *Science and Hypothesis*

E. S. Reed and R. Jones (eds). *Reasons for realism: Selected essays of James J. Gibson*. 385 – 388. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Rosen, R. (1991). *Life itself: A comprehensive inquiry into the nature, origen, and fabrication of life*. New York: Columbia University Press.

Russell, B. (1945). *A history of western philosophy*. New York: Simon & Schuster.

Shaw, R. (??). Processes, acts, and experiences: Three stances on the problem of intentionality. *Ecological Psychology*.

Shaw, R., Flascher, O., & Kadar, E., (1995). Dimensionless invariants for intentional systems: Measuring the fit of vehicular activities to environmental layout. J. Flach, P. Hancock, J. Caird, & K. Vicente (eds.). *Global perspectives on the ecology of human-machine systems, vol 1.* Hillsdale NJ: LEA, 293-357.

Shaw, R. and Kinsella-Shaw, J. (1988). Ecological mechanics: a physical geometry for intentional constraints. *Human Movement Science*, **7**, 155.

Shaw, R and Kinsella-Shaw, J. (2014). Intentional Quantum Dynamics: Entangling Choices and Goals. Conference: Quantum Interaction 8th International Conference, QI 2014 Filzbach, Switzerland, June 30 – July 3, 2014, Volume: ISSN 0302-9743 ISSN 1611-3349 (electronic) Lecture Notes in Computer Science ISBN 978-3-319-15930-0 ISBN 978-3-319-15931-7 (eBook)

Shaw, R., Kugler, P. & Kinsella-Shaw, J. (1990). Reciprocities of intentional systems. R. Warren & A. Wertheim (Eds.). *Control of self-motion.* Hillsdale NJ: Lawrence Erlbaum & Associates.

Shaw, R. E. and Kadar, E. Cosmological psychology: Reconciling the roles of consciousness in quantum brain dynamics, relativistic geometrodynamics, and psychodynamics. Proceedings Second World Congress on Synthesis of Science and Religion. R. Gomatan et al (Eds.), Bhakti Vedanta Institute, Oakland, CA (1997).

Spinoza, B. (1677). *The ethics demonstrated with geometric order.*

Wheeler, J. A. & Feynman (1945). *Rev. Mod. Phys.* **17**. 157.

Whitehead, A. N. (1978). *Process and reality: An essay in cosmology* (corrected edition). New York: Free Press.

Wigner, E. P. (1964). *Monist*, **48**, 248.