24 Why Are the Laws of Nature as They Are? What Underlies Their Existence?

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CONTENTS

THE EXISTENCE OF THE LAWS OF NATURE

A deep issue in both cosmology and human life is, *What underlies the existence of the laws of nature?* These laws define the possibility space within which the Universe and life come into being. We want to understand the existence and nature of causal laws that allow true complexity, such as ourselves—our bodies and minds, our actions and thoughts and emotions—to come into being. These laws are simply taken for granted in most biological and evolutionary discussions; but in the context of fundamental discussions concerning cosmology and life, one is entitled to query both their nature and their existence, for they shape the nature of physical existence and are the foundational reasons that any life whatever is possible. No life, and no biological evolutionary processes of any kind, would be possible if these laws were substantially different.

The fundamental laws of nature are based in mathematically describable variational principles for physical entities* invariant under symmetry groups and subject to quantum mechanical dynamics (Cottingham and Greenwood, 2007). The coupling constants that relate resulting forces and particles are such that complexity, including consciousness, can emerge out of these basic physical constituents; this is *a priori* a highly improbable state of affairs (Davies, 1982; Barrow and Tipler, 1986; Balashov, 1991; Rees, 2000, 2001).

A series of fundamental issues arise:

- Why do any such laws exist at all, and why do they have the nature they have, leading to our physical and mental existence?
- Is the ultimate reason pure happenstance, probability, necessity, or purpose?
- What is the nature of their existence—is it prescriptive or descriptive?

THE HIERARCHY OF COMPLEXITY

Our cosmological context (Harrison, 2000; Silk, 2005; Ellis, 2006) is an evolving Universe that is initially structureless, but eventually physical processes lead to the existence of galaxies, stars, and planets. The emergence of true complexity, including living beings such as ourselves, occurs on some suitable planets imbedded in this larger context. Complexity arises in modular hierarchical structures (Simon, 1982; Peacocke, 1989; Flood and Carson, 1990; Booch, 1994; Scott, 1995; Campbell and Reece, 2005; Ellis, 2008b), which underlie biological function, as indicated in Table 24.1. These structures emerge from the underlying physical basis in 3 very different, but interrelated ways:

TABLE 24.1

The Hierarchy of Structure and Complexity Underlying Human Existence is Characterized by the Various Sciences Appropriate for Studying Each Level

Sociology/Economics/Politics
Psychology
Botany/Zoology/Physiology
Cell Biology
Biochemistry
Physical Chemistry
Atomic Physics
Nuclear Physics
Particle Physics

* One considers a quantity (the "action"), depending on the path from an initial to final point, and determines on which path this quantity is either a minimum or maximum as one varies the path.

- *In evolutionary terms*, on very long timescales (>10^6 years). There was no life in the Universe when it was 300,000 years old or on Earth 4 billion years ago; living beings came into existence through an evolutionary process that lasted billions of years and generated complexity where none had existed before.
- *In developmental terms*, on medium timescales (hours to 10^2 years). Each higher-level animal, including human beings, starts off as a single living cell and then develops into a multicellular organism (~10^{13} interacting cells) through developmental processes that create functioning physiological structures (Gilbert, 2006).
- *In functional terms*, on short timescales (milliseconds to minutes). We are each made up of inanimate objects (protons, neutrons, and electrons) that are fashioned into physiological systems that together make a living being. Life emerges through the ongoing cooperation of these basic physical entities (Campbell and Reece, 2005).

Once life has been initiated, the developing organisms must continually keep functioning effectively at each stage of the developmental and evolutionary processes, despite the enormous changes in structure and complexity that occur as complexity develops. Thus, the functional processes evolve on both evolutionary and developmental timescales.

I suggest that at each level of the hierarchy of complexity, universal principles apply, describable as effective laws applicable at that level. Each level exists in its own right, even though it is based in lower levels. The way the lower-level laws work out is shaped by the higher-level contexts in which they act, deriving from action at lower level, but with their own autonomy of operation, leading to effective laws at each level. These effective laws control what happens at each level in a way independent of time and place and independent of our understandings and descriptions, hence they may be thought of as having an existential reality describable in Platonic terms.* This is all possible because both bottom-up and top-down causation takes place in the hierarchy of complexity.

Bottom-up Action

A fundamental understanding we have attained through 300 years of scientific endeavor is that all complex objects are made of the same basic materials (atoms fashioned into molecules), with microforces determining what happens at the lower levels, and hence underlying properties at the higher levels. *Bottom-up action* is when what happens at the higher levels in the hierarchy is controlled by what happens at the lower levels (Figure 24.1, left). Examples are abundant:

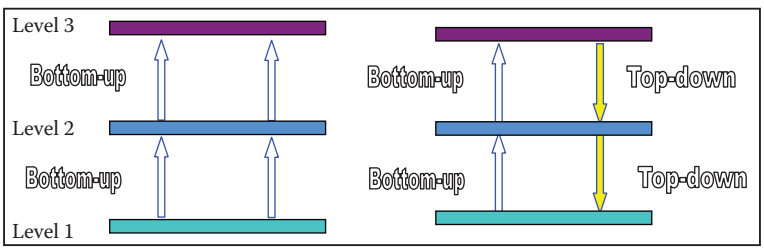

FIGURE 24.1 *Left:* Bottom-up causation. *Right:* Bottom-up and top-down causation. The fundamental importance of top-down causation is that it changes the causal relation between upper and lower levels in the hierarchy of structure and organization.

* A Platonic kind of existence is an existence in an abstract space, separate from physical reality.

- Microphysics underlies macrophysics, e.g., the kinetic theory of gases and the theory of solids, determining properties of gases (such as the temperature-pressure relation) and solids (such as electrical conduction and thermal capacity) from the underlying material properties (Goodstein, 1985; Durrant, 2000).
- Physics underlies chemistry, e.g., determining thermodynamic properties of matter and th nature of the chemical bond (Laidler et al., 2003).
- Molecular processes underlie organic life (Scott, 1989).
- Cells with their own internal function underlie all life (Harold, 2001).
- Physics and chemistry underlie the functioning of the brain (Scott, 1995).
- Individual human behavior underlies the functioning of society (Berger, 1963).

Bottom-up causation is the focus of reductionist accounts of life. However, although it is indeed a key factor in what occurs, it is not the whole story.

Top-down Causation

The fundamental importance of top-down causation is that it changes the causal relation between upper and lower levels in the hierarchy of structure and organization: causes come from some upper levels to lower levels, as well as from lower levels to upper levels (Ellis, 2008a,b).

In addition, top-down causation takes place in the hierarchy of complexity (Campbell, 1974; Murphy and Ellis, 1995; Noble, 2007; Ellis, 2008b). Through boundary effects (linking the system to the environment) and structural relations in the system itself, the higher levels of the hierarchy causally effect what happens at the lower levels (Figure 24.1, right) by determining the context of the lower-level processes. Through coordinating the action of the lower levels, the higher levels attain their causal effectiveness. Top-down causation is prevalent in the real physical world and in biology because no real physical or biological system is isolated. It is the occurrence of multiple top-down actions in conjunction with bottom-up action that enables the self-organization of complex systems. Here are some examples:

1. The synthesis of light elements in the early Universe (Silk, 2005). The amount of helium produced depends on the rate of change of temperature in the expanding Universe, which is controlled by the gravitational equations and the average amount of matter in the Universe. Thus, quantities defined at the cosmological level control the products of detailed nuclear reactions at the micro level.
2. The functioning of the molecular systems underlying cardiac behavior is determined in a top-down way by the state of the heart as a whole (Noble, 2007).
3. Training of artificial neural networks to perform a specific task (say, letter recognition) determines the interaction weights in the network (Bishop, 1999). This is a form of top-down causation from the pattern to be recognized (a high-level concept, as it is defined in terms of the relation between the elements) to the low-level property of network weights. Decision making is a property of the network rather than of any single cell.
4. The power of the human mind in the real world: for example, design and construction of a jumbo jet aircraft, thereby determining the disposition of myriads of atoms (Ellis, 2008b).

Numerous other examples are given in Ellis (2008b), which also looks at the key question: *How is effective top-down causation possible without violating the integrity of bottom-level causation?* The basic answer is that the lower-level physics does not uniquely determine higher-level outcomes, not only because of statistical effects, but because quantum theory does not determine a unique physical outcome, *even in principle* (Feynman, 1985; Penrose, 1989b, 2005; Polkinghorne, 2002; Al-Khalili, 2003). Physics gives the statistics of outcomes, but not the unique actual outcome. This opens up the space for selectional principles to operate as a form of top-down action.

The Causal Efficacy of Nonmaterial Entities

The overall importance of this discussion is that it is through top-down action that immaterial entities can have causal effects on the physical world (Ellis, 2008b).

The first important example is social constructions, such as the rules of chess and the value of money. These are indeed causally effective in the real world, but they are not the same as a state of any single physical object; in particular, they are not equivalent to any individual's brain state (although they are realized through such states).

First, the ontological status of rules, such as, say, for chess, is not dependent on any individual's brain or state of mind. Rather, such rules are an abstract social construction, shared by many people and arrived at through social interactions over the course of time, with many different embodiments: they are written down, can be talked about, are thought about, are embodied in computer programs, and so on. They are not physical entities, but they are causally effective. Similarly, physically, money is just coins or pieces of paper with patterned marks on them. This does not explain its causal significance. The effectiveness of money, which can cause physical change in the world such as the construction of buildings, roads, bridges, and so on, by top-down action of the mind to material objects, is based in social agreements that lead to the value of money (pricing systems) and exchange rates. These are abstract entities arising from social interaction over an extended period of time and are neither the same as individual brain states nor equivalent to an aggregate of current values of any lower-level variables (although they may be represented by, and are causally effective through, such states and variables).

Second, abstract entities of a Platonic nature can also be causally effective in the real world through the action of the human mind. For example, mathematics comprehension and utilization is a case of causation from a Platonic world of mathematical abstractions to the human mind, being realized in details of neuronal connections and then into the real world, where it is causally effective in terms of creating patterns on paper and through underlying physics, engineering, commerce, and general planning.

The existence of a Platonic world of mathematical objects is strongly argued by Penrose (1997, 2005) and Changeux and Connes (1998), the point being that major parts of mathematics are discovered, rather than invented (rational numbers, 0, irrational numbers, and the Mandelbrot set being classic examples; see, e.g., Seife 2000 for the case of 0). They are not determined by physical experiment, but are rather arrived at by mathematical investigation. They have an abstract, rather than an embodied, character; the same abstract quantity can be represented and embodied in many symbolic and physical ways (Penrose, 2005), and these representations form an equivalence class. They are independent of the existence and culture of human beings; it is plausible that the same features will be discovered by intelligent beings in the Andromeda Galaxy as here, once their mathematical understanding is advanced enough (which is why they are advocated as the basis for interstellar communication). This Platonic world is, to some degree, discovered by humans and represented by our mathematical theories; that representation is a cultural construct, but the underlying mathematical features they represent are not—indeed, like physical laws, they are often unwillingly discovered, as with, for example, the irrationality of the $\sqrt{2}$ and the number π. This world is causally efficacious in terms of the process of discovery and description: one can, for example, print graphic versions of the Mandelbrot set in a book, resulting in a physical embodiment in the ink printed on the page. The causal variables here are not coarse-grained lower-level variables and exist independent of the mind, even though they are discovered and comprehended there.

THE NATURE OF EXISTENCE

It is the existence of these causally effective immaterial entities that enables us, indeed requires us, to contemplate kinds of existence other than that of merely physical entities. In discussing this, I *take as given the reality of the everyday world*—tables and chairs, and the people who perceive

them—and then assign a reality additionally to each kind of entity that can have a demonstrable causal effect on that everyday reality. The problem then is to characterize the various kinds of independent reality that may exist in this sense. Taking into account the causal efficacy of all the entities discussed above, I suggest as a possible completion of the proposals by Popper and Eccles (1977) and Penrose (1997, 2005) that the 4 Worlds indicated in Table 24.2 are ontologically real (that is, they really do exist physically).* These are not different causal levels within the same kind of existence; rather, they are quite different kinds of existence, but related to one another through causal links. The challenge is to show first that each is indeed ontologically real, and second that each is sufficiently and clearly different from the others that it should be considered as separate from them. I now discuss them in turn; see Ellis (2004) for a more detailed discussion.

Matter and Forces

World 1 is the physical world of energy and matter, hierarchically structured to form lower and higher causal levels whose entities are all ontologically real.

This is the basic world of matter and interactions between matter, based at the micro-level on elementary particles and fundamental forces, and providing the ground of physical existence. It comprises *inanimate objects* (both naturally occurring and manufactured), *living things* (amoebae, plants, insects, animals, etc.), and *human beings,* who have the unique property of self-consciousness.

The hierarchical structure in matter is a real physical structuration and is additional to the physical constituents that make up the systems themselves. It provides the basis for higher levels of order and phenomenology, and hence of ontology. Ontological reality exists at each level of the hierarchy. Thus, we explicitly recognize as being real the following: quarks, electrons, neutrinos, rocks, tables, chairs, apples, humans, the world, stars, galaxies, and so on. The fact that each is made up of lower-level entities does not undermine its status as existing in its own right (Sellars, 1932). We can attain and confirm high representational accuracy and predictive ability for quantities and relations at higher levels, independent of our level of knowledge of interactions at lower levels, giving well-validated and reliable descriptions at higher levels accurately describing the various levels of emergent nonreducible properties and meanings.

Consciousness

World 2 is the world of individual and communal consciousness: ideas, emotions, and social constructions. This again is ontologically real (it is clear that these all exist) and causally effective.

These worlds are different from the world of material things and are realized through the human mind and society. They are not brain states, although they can be represented as such, for they do not reside exclusively in any particular individual mind. They are the foundation for social interactions and intellectual activity. They are causally effective because, as discussed above, they do

TABLE 24.2

The Different Kinds of Reality Implied by Causal Relationships can be Characterized in Terms of 4 Worlds, Each Representing a Different Kind of Existence

- *World 1:* Matter and Forces
- *World 2:* Consciousness
- *World 3:* Physical and Biological Possibilities
- *World 4:* Abstract (Platonic) Reality

* "Ontology" is the philosophical study of the nature of being or existence.

indeed have the capacity to change the state of the physical world. The existence of houses and automobiles, of books and computers, of cities and factories, is evidence of this effectiveness.

Physical and Biological Possibilities

World 3 is the world of possibilities. This characterizes the set of all physical and biological possibilities, from which the specific instances of what actually happens in World 1 are drawn.

This world of possibilities is ontologically real because of its rigorous prescription of the boundaries of what is possible—it provides the framework within which World 1 exists and operates, and in that sense it is causally effective. This world is different from the world of material things, for it provides the background within which that world exists. In a sense, it is more real than that world because of the rigidity of the structure it imposes on World 1. There is no element of chance or contingency in it, and it is certainly not socially constructed (although our understanding of it is so constructed). It rigidly constrains what can happen in the physical world.

If one believes that physical laws are prescriptive, rather than descriptive (cf. the discussion below), one can view the world of all physical possibilities as being equivalent to a complete description of the set of physical laws (for these determine the set of all possible physical behaviors through the complete set of their solutions). The formulation given here is preferable in that it avoids making debatable assumptions about the nature of physical laws, but still incorporates their essential effect on the physical world. Whatever their ontology, what is possible is described by physical laws such as those identified in Table 24.3.

Abstract (Platonic) Reality

World 4 is the Platonic world of (abstract) realities that are discovered by human investigation, but that are independent of human existence. They are not embodied in physical form, but they can have causal effects in the physical world.

As discussed above, the existence of a world of mathematical objects is strongly argued by Penrose (1997, 2005) and Changeux and Connes (1998). It is a quite different kind of existence from that of physical entities: it is eternal and unchanging, and so is of a Platonic character.

Existence and Epistemology

The major proposal (Ellis, 2004) is that *all these worlds exist—Worlds 1 through 4 are ontologically real and are distinct from one another*, as argued above. These claims are justified in terms of the effectiveness of each kind of reality in influencing the physical world.

What then of epistemology (the nature of our knowledge of how things are)? Given the existence of the 4 Worlds as described above, the proposal here is that *epistemology is the study of the relation*

TABLE 24.3
Three Fundamental Laws of Nature

The Second Law of Thermodynamics
Entropy always increases
Maxwell's Laws of Electromagnetism
Electric charges cause electricity and magnetism, which in turn determine the motion of the charges
Einstein's Law of Gravitation
Matter causes spacetime curvature

between World 2 and Worlds 1, 3, and 4. It attempts to obtain accurate correspondences to quantities in all the worlds by means of entities in World 2.

This exercise implicitly or explicitly divides World 2 theories and statements into (1) true/accurate representations, (2) partially true/misleading representations, (3) false/poor/misleading representations, and (4) representations where we do not know the situation. These assessments range from statements such as "It is true her hair is red" or "There is no cow in the room" to "electrons exist," "Newtonian theory is a very good description of medium-scale physical systems at low speeds and in weak gravitational fields," and "The evidence for UFOs is poor." This raises interesting issues about the relation between reality and appearance: for example, everyday life gives a quite different appearance to reality than microscopic physics—as Eddington (1928) pointed out, a table is actually mostly empty space between the atoms that make up its material substance; but in our experience it is a real, hard object. As long as one is aware of this, it can be adequately handled.

THE NATURE OF THE LAWS OF NATURE

Given this understanding of the kinds of existence, what can we say about the laws of nature? These are impersonal dynamical principles operating on material entities in a spacetime that are needed for reliable emergence of complex orders of existence, such as galaxies, stars, planets, and life, as discussed above. This emergence can happen only if there are precisely ordered evolving relationships and processes governing the behavior of matter at the basic levels that are such as to allow the higher levels to emerge.

The Basic Laws

The hierarchy of complexity is based at the lower levels in specific families of particles (Cottingham and Greenwood, 2007), interacting through 4 fundamental forces that are presumed unified at high energies. Their behavior is based in quantum mechanics, with interactions describable by variational principles subject to special relativity theory and to fundamental symmetries entailing conservation laws, but with the exact symmetries of the theory broken. These interactions involve specific masses and interaction strengths. All of this takes place in a 4-dimensional Riemannian spacetime, whose geometry is determined by the matter content of the spacetime.

Emergent Laws

It is far from obvious that these fundamental laws can lead to the emergence of complexity. Regularities of behavior at the higher levels of the hierarchy are characterized by emergent laws at that level; for example, the perfect gas law, Ohm's law, Bernoulli's law, and so on are higher-level physical laws. Each has a domain of validity representing the conditions where it gives reliable results (for example, the temperature and density must be neither too high nor too low for each of these laws to be true). Within their domain of validity, these are equally as valid as the fundamental laws, for they can be thoroughly tested and shown to be accurate predictors of the relevant physical behavior. Similarly, Darwin's theory of evolution through natural selection is an emergent law at the biological population level, as are the laws of genetic inheritance, whereas the Hodgkin–Huxley equations for a nerve's action potential are an effective biological law at the physiological level. The issue of whether there are reliable psychological laws is more uncertain (for a discussion, see Silverberg, 2004); but there certainly are universal regularities applicable to human life, such as the need for food and the inevitability of death.

Actually, all the physical laws of which we are certain (such as those in Table 24.3) are emergent, rather than fundamental laws; for example, both Newton's and Einstein's laws of gravity are presumed to be approximations to some deeper underlying quantum theory of gravity. Indeed, we do not even know what the fundamental physical laws are (string theory/M theory is a popular contender, but it does not yet have a unique formulation and is not experimentally tested).

TABLE 24.4

Examples of the Geometrical Nature of the Laws of Physics

- Geometric conservation of particles or fields in a 3-dimensional space gives an inverse-square law.
- Parallel transport along curves underlies Yang–Mills theory, the basis of the standard model of particle physics.
- The Aharanov–Bohm effect and Feynman path integrals suggest that holonomy (based on parallel transport along closed curves) is a fundamental entity in quantum theory.
- Geodesic paths (corresponding to extreme distances) underlie variational principles, as a geometrical description of solutions of dynamical equations.

Their Mathematical Description

A mathematically useful description is a probable outcome of reliable behavior, such as is described by physical laws. At a certain level, this is an answer to Wigner's (1960) famous question, *Why are physical laws so well describable by mathematics?*

As mathematics describes ordered patterns of relationships, it is perhaps not surprising that these relationships and processes can be described mathematically. The very nature of mathematics is indeed to describe patterns (Devlin, 1996): in space and in time, and indeed within patterns (leading to recursion and higher-order relations). What is surprising is that *fundamental physical relationships can often be described so accurately by very simple laws*, such as an inverse-square law. My suggestion is that *this is because the underlying nature of these fundamental laws is geometrical*, which results in their being accurately represented by simple analytic relations. Some examples are shown in Table 24.4.

It is a basic principle of mathematics that geometrical relations can be represented in analytic form, and vice versa; the proposal here is that the geometrical form of physical relationships is the more fundamental, and that is the reason for the relatively simple analytic forms for physical laws.

The Nature of the Laws of Physics

Two major issues arise in regard to the existence of the laws of physics. The first is the nature of these laws: are they *descriptive*, *just characterizing the way things are*, or are they *prescriptive*, *forcing them to be this way* (Carroll, 2004)? For example, quantum field theory applied to the standard model of particle physics is immensely complex (Peskin and Schroeder, 1995; see Table 24.5).

What is the nature of existence of all this quantum apparatus? Are they just descriptions devised by our minds, or are they the way things really are? Derived (effective) theories, including classical (nonquantum) theories of physics, equally have complex abstract structures underlying their use: force laws, interaction potentials, metrics, and so on. The same issue arises.

If laws are descriptive, this is just the way matter behaves; that is, the laws are phenomenological: they just describe what is. They are mathematical and physical constructs that happen to

TABLE 24.5

Entities Assumed to Exist When Quantum Field Theory Applies

- Hilbert spaces, operators, commutators, symmetry groups, higher-dimensional spaces;
- Particles/waves/wave packets, spinors, quantum states/wave functions;
- Parallel transport/connections/metrics;
- The Dirac equation and interaction potentials, Lagrangians, and Hamiltonians;
- Variational principles that seem to be logically and/or causally prior to all the rest.

characterize reasonably accurately the physical nature of physical quantities. That such descriptions should be accurate predictors of physical behavior is in itself remarkable. But then from where do the properties of matter derive, leading to these descriptions? How are its characteristic behaviors enforced? The specific issue arising is, *Why does all matter have the same properties wherever it exists in the Universe?* Why are electrons here identical to those at the other side of the Universe if the laws are only descriptive? We seem to have no handle with which to investigate such questions. But we can claim that even if this is their nature, the laws have an existence independent of human minds: the phenomenological descriptions are accurate and will be derived as such by any other intelligent beings in the Universe. In this sense, they are as ontologically real as the laws of mathematics, discussed above: they exist universally as descriptions of the nature of reality.

If they are prescriptive, the laws of physics somehow exist in a form that enables them to control the nature of existence. They then represent a fundamental underlying reality, as entities that have the power to control the behavior of physical quantities. Then matter will necessarily be the same everywhere because their behavior is determined by these laws (assuming that the laws themselves are invariable). The issue arising then, is, I*n what way—where and how—do laws of physics exist and impose themselves on the matter in the Universe?* Do they, for example, have an existence in some kind of Platonic space that controls the nature of matter and existence?

The second issue, related to the first, is, *Do these laws in some sense precede the existence of the Universe, somehow governing its coming into being, or do they come into being with the Universe?* This is where this issue relates deeply to the nature of cosmology.

Many theories of the creation of the Universe assume that all these laws, or at least a basic subset of them, preexist the coming into being of the physical Universe because they are presumed to underlie the creation process; for example, the entire apparatus of quantum field theory mentioned above is often taken for granted as preexisting our Universe. This is, of course, an unprovable proposition, but it appears to be widely held. If it is true, it seems to me to support the idea that the laws are indeed ontologically real: indeed, more real than the Universe itself, which is then a transient manifestation of this underlying immutable reality. And it is difficult to see any other basis for the coming into being of matter effectively obeying physical laws.

The Ontological Nature of Effective (Higher-Level) Laws

As discussed in "Emergent Laws" above, we actually deal with effective laws only: we do not yet have access to the fundamental laws. Hence, my position is that the existential status of fundamental and effective laws has to be the same: they are both genuine representations of the way things behave at the different levels and also preexist the coming into being of any matter that materializes their nature or any mind that comprehends them. In this way, they are ontologically real (i.e., they actually exist), whether descriptive or prescriptive. And this applies at each level of the hierarchy: chemical laws and biological laws are just as real as physical laws, independent of the existence of any human mind.

This ontological reality can be shown by their causal effectiveness. Consider how Maxwell's *theory* of electromagnetism (an abstract entity, described by Maxwell's equations) led to the development of radio, and then to the existence of TV, cell phones, and so on. Maxwell's theory is not the same as any single person's brain state. It can be represented in many ways (on blackboards, in print, on computer screens, in spoken words, in neural connections) and many formalisms (via 3-dimensional vectors or 4-dimensional tensors, for example); these various representations together form an equivalence class, as they all lead to the same predicted outcomes. How do you demonstrate this kind of causation? Design an artifact such as a cell phone through use of Maxwell's theory, and then construct it and operate it. The abstract theory will have altered physical configurations in the real world and hence is causally effective. It is therefore an ontologically existing entity, successfully representing the nature of physical reality in a way that will be accessible to advanced civilizations anywhere in the Universe. The same is true, for example, of the laws of thermodynamics.

As noted in "Physical and Biological Possibilities" above, one can avoid talking about the laws of behavior *per se* by instead considering the *space of possibilities* underlying what exists physically, rigorously constraining the possible natures of what actually comes into existence. This space is more or less uniquely related to the underlying laws in the same way that the space of solutions of differential equations is related to the nature of the equations. This enables one to avoid the issue of the ontology of the laws, but does not solve it. It does confirm, however, that we can think of the space of possibilities, essentially representing the outcomes, and, hence, nature of the underlying laws, as genuinely existing: it is a transcendent eternal reality, governing the nature of what can actually come into existence.

ULTIMATE REASONS

Philosophers have debated for millennia whether the ultimate nature of existence is purely material or embodies some form of rationality *(logos)* and/or purpose *(telos).* What in the end underlies it all? Is the ultimate nature of the Universe purely material, or does it in some way have an element of the mental? That profound debate is informed by physical cosmology, but cannot be resolved by the physical sciences alone. Given suitable lowest-level laws, with restricted structure and coupling constants (Davies, 1982; Barrow, 2003), a hierarchy of complexity with effective higher-level laws can emerge. But what essentially underlies the lowest-level laws on which the rest is based? Why do they exist, with the form they have that allows life to exist? Is the ultimate underlying reason pure chance, probability, necessity, or purpose? I consider each of these possibilities in turn.

Pure Chance, Signifying Nothing

The initial conditions in the Universe just happened, and they led to things being the way they are now, by pure happenstance. This is just the way it was: there is no suggestion that it was a probable outcome of some underlying dynamics. Probability does not apply. There is no further level of explanation that applies; searching for "ultimate causes" has no meaning.

This is a logically possible ultimate reason, but has no further explanatory power; indeed, it is denial that at a fundamental level there is any explanation and so is unsatisfactory to almost everyone (whether scientifically or religiously inclined), primarily because we know that explanations (both impersonal and personal) do indeed exist in the social and mental world. Furthermore, it is difficult to resist the argument that the outcome is so unlikely that pure chance simply is not credible as a reason. Not merely qualia and emotions, but also complex theories such as Einstein's theory of relativity and quantum field theory have come into existence as extraordinarily complex theoretical constructs. To suggest that these can all arise without existence of any underlying cause, or can come into existence out of pure chaos or nothingness without any further guiding structure, seems simply absurd; but if you have such a cause or guiding structure, you do not have pure chaos or nothingness.

This is certainly logically possible and, indeed, is philosophically unassailable; but it is not satisfying as an explanation, as we obtain no unification of ideas or predictive power from this approach. Nevertheless, some implicitly or explicitly hold this view.

High Probability

The idea is that although the structure of the Universe appears to be very improbable, in fact for physical reasons it is highly probable. This is often realized by some version of the idea of *universality*: "All that is possible, happens." The current embodiment of this idea is via the concept of a Multiverse: an ensemble of universes or of disjoint expanding universe domains is realized, in which all possibilities occur (Tegmark, 1998, 2003; Rees, 2000, 2001). It is then supposed that the anthropic principle is realized in both its strong form (if all that is possible happens, then life

must happen: it is inevitable) and its weak form (life will occur only in some of the domains that are realized; these are picked out from the others by the fact that we can exist only where life is possible, so the anthropic principle is viewed as a selection principle in the Multiverse context). The favored cosmological setting for this idea is chaotic inflation (Linde, 1986, 1990; Vilenkin, 2006; Guth, 2007; Weinberg, 2007), sometimes integrated with the idea of the landscape of string theory (Susskind, 2005).

These arguments are only partially successful, even in their own terms. They run into problems if we consider the full set of possibilities: discussions proposing this kind of view actually implicitly or explicitly restrict the considered possibilities *a priori*, for otherwise it is not very likely that the Universe will be as we see it (inflation does not in fact solve the issue of probability; see Penrose, 1989a, 2005). Besides, we do not have a proper measure to apply to the set of initial conditions, enabling us to assess these probabilities. Furthermore, the Multiverse hypothesis is not observationally or experimentally provable: the supposed other universe domains are not observable by any conceivable form of astronomical observation, as they lie beyond the visual horizon, and the assumed underlying physics is unproven and probably untestable (Carr and Ellis, 2008; Ellis, 2009).

Despite these problems, this approach has considerable support in the scientific community, particularly via the chaotic inflationary proposal. It is an attractive explanatory proposal, but is not testable physics; and it is, in fact, not an ultimate explanation. If it were to exist, the whole issue of probability arises again as regards the Multiverse (why this one, rather than another?), leading to the specter of infinite regress: we might explain the probability of a specific Multiverse by assuming an ensemble of multiverses. For the scientist, probability trumps a lack of any explanation. But probability by itself is always an incomplete explanation: for what underlies the laws that govern those probabilities? Why are the assumed laws underlying probabilistic calculations valid in the first place? In any case, probability is a good explanation for intermediate levels of explanation where the dynamical laws have already been established and some kind of variation takes place through either irreducible uncertainty (quantum mechanics) or statistical variation, but there is no evidence that it applies in the context of the Universe and ultimate causation; indeed, the very concept of probability is not applicable if there is only 1 object (the unique Universe) in existence. Application of probability arguments to the Universe itself is dubious because the Universe is unique (Ellis, 2006).

In brief: the unique Universe that actually exists may well not be probable, as was taken for granted in the past; indeed, it certainly is improbable because it is of such a nature as to allow life to exist. The whole Multiverse endeavor is an attempt to make the improbable appear probable. It only postpones the problem; it does not solve it.

An interesting variant is the idea of *cosmological natural selection* (Smolin, 1992). If a process of re-expansion after collapse to a black hole were properly established, it would open the way to the concept of evolution of the Universe not merely in the sense that its structure and contents develop in time, but in the sense that the Darwinian selection of expanding Universe regions could take place. The idea is that there could be collapse to black holes followed by re-expansion, but with an alteration of the constants of physics through each transition, so that each time that there is an expansion phase, the action of physics is a bit different. The crucial point then is that some values of the constants will lead to production of more black holes, while some will result in less. This allows for evolutionary selection favoring the expanding Universe regions that produce more black holes (because of the favorable values of physical constants operative in those regions), for they will have more "daughter" expanding Universe regions. Thus, one can envisage natural selection favoring those physical constants that produce the maximum number of black holes.

This is an intriguing effort to bring ideas of natural selection, as discussed in "The Causal Efficacy of Nonmaterial Entities" above, into cosmology; but again it is only partially successful (Rothman and Ellis, 1992) and does not solve the ultimate issues: if this indeed takes place, then why the laws of physics that allow it to take place?

Necessity

This is the idea that things have to be the way they are; there is no other option. The features we see and the laws underlying them are demanded by the unity of the Universe. Coherence and consistency require that things must be the way they are; the apparent alternatives are illusory. Only 1 kind of physics is self-consistent: all logically possible universes must obey the same physics.

To show that this is the case has been one of the most profound goals of theoretical physics, following up powerful unification principles with the aim of eventually devising a single theory of fundamental physics with no free parameter whatever. To really succeed would be a wonderful achievement, potentially leading to a self-consistent and complete scientific view of the foundations of physical existence. But we can imagine alternative universes!—why are they excluded? Indeed, this project seems to fail in any case because fundamental physics is presently going the other way: the hoped-for uniqueness of fundamental theories has evaporated and been replaced by the multiple billions of possibilities of string vacua (as explained by Susskind, 2005). Furthermore, here we run into the problem that we have not succeeded in devising a fully self-consistent view of physics: neither the foundations of quantum physics nor those of mathematics are on a really solid consistent basis. Until these issues are resolved, this line cannot be pursued to a successful conclusion.

Additionally, if this approach ever succeeded, it would in fact worsen, rather than solve the fine-tuning problem. If there were just in the end 1 set of constants of nature that are consistent with one another, why should they take those precise improbable values that just happen to allow the existence of life? In the end, this is highly implausible. How could it be that the existence of love and pain and intellect is *necessarily* written into variational principles and mathematical symmetries such as SU(10) or E8 as the inevitable outcome of the only consistent possibility for their implementation?

In any event, just as in the previous case, this is not an ultimate answer: the attempt to implement necessity leaves unexplained the choice of those specific realized features of physics that then lead to the necessity. Why should physics have the specific restricted nature that leads to the necessity of particular high-level features?

This whole project is an attempt to implement the idea of necessity underlying existence and causation, but it necessarily has to be incomplete. What has to be explained includes the following: *Where do the very causal categories of chance, necessity, and purpose come from? How do these concepts arise and have meaning, and what underlying ontological entities or causation do they represent? Why are they themselves necessary? How can they even be relevant, as this whole discussion supposes, if there is no ontological referent that makes the dichotomy between them a meaningful issue?* That itself surely cannot be shown to be necessary: for it is the very category of necessity that has to be explained.

Purpose or Design

The symmetries and delicate balances we observe require an extraordinary coherence of conditions and cooperation of causes and effects, suggesting that in some sense they have been purposefully designed. That is, they may show evidence of intention, both in the setting of the laws of physics and in the choice of boundary conditions for the Universe, in such a way that life will inevitably come into being.

Unlike all the other options just discussed, this introduces an element of meaning, of signifying something, at the foundations. In all the other options, life exists by accident, as a chance by-product of processes blindly at work. Here, the view is that the totally different quality of existence that emerges in human life from the underlying physics, and the huge fine-tuning that is needed for this to occur, suggests an underlying intention or purpose that this should indeed be the case: *it was meant to be that way.* The modern version, consistent with all the scientific understandings of causation, would see some kind of purpose underlying the existence and specific nature of the

laws of physics and the boundary conditions for the Universe, in such a way that life (and eventually humanity) would then come into existence through the operation of those laws, then leading to the development of specific classes of animals through the process of evolution as evidenced in the historical record.

This is the only line of reasoning that does not just relegate the problem to a deeper level: assuming a higher intention is realized through physical reality by design enabling higher-level purpose and ethical principles to be embodied through the nature of the resulting possibility spaces. It is this higher-level set of purposive principles—the underlying *telos*—that is then the ultimate cause of both existence and its specific nature. It is unlikely that this kind of underlying intention could be effective, with emergence of a physical structure where purpose can be deployed so that ethical behavior is meaningful, unless on the one hand the lower-level laws had the kind of impersonal regular behavior that allows reliable higher-level behavior to emerge, thus allowing a mathematical description, and on the other hand something like quantum uncertainty were present so as to free the higher levels from total lower-level determinism. A layered structure emerges: purpose underlies impersonal laws that underlie the emergence of purpose. Two kinds of causation, intentional and impersonal, which undoubtedly both exist in the world around us, occur in an intertwined way, with chance events intervening and helping to lead to the richness of outcomes we see around us.

Thus, implementing this proposal necessarily invokes the other 2: meaningful purpose entails both necessity and chance. Each of these kinds of causation (chance in the sense of probability, necessity, and purpose) does indeed occur in the world in various contexts, but the only one that seems to entail the possibility of being a deep foundation for the others is purpose. There will be some who will reject this possibility out of hand, as meaningless or as unworthy of consideration. However, it is certainly logically possible. Given an acceptance of evolutionary development, it is precisely in the choice and implementation of particular physical laws and initial conditions, allowing such development, that the profound creative activity occurs; and this is where one might conceive of design taking place.

This then relates to religious or spiritual views of the nature of reality, supported by a variety of evidence relative to those domains (that evidence certainly exists, with a wide variety of natures and in a wide variety of contexts; the argument is about its acceptability in each case).

THE NATURE OF EVIDENCE

What Kind of Evidence Is Relevant?

In examining these fundamental issues, one needs to take into account all the scientific evidence about the nature of physics, chemistry, and biology that comes from laboratory experiments, as well as about the nature of the Universe that comes from astronomical observations. In particular, I suggest that we are entitled to take the nature of the possibility space allowing existence of material entities supporting consciousness and purposive causation as evidence concerning the ultimate reasons the basic laws are as they are. But equally, as well as the discoveries attained by the scientific method, one should take into account data about the natures of our existence that come from our daily lives and the broad historical experience of humanity (our experiences of ethics and aesthetics, for example).

The claim I make is that the kinds of personal world experience we each have are certainly data on the nature of reality because we live in and indeed are part of reality. They do not have the quality of the strictly repeatable experiments that science engages in—they are much richer than that. As an example, many writings claim that there is no purpose in the Universe: it is all just a conglomerate of particles proceeding at a fundamental level in a purposeless and meaningless algorithmic way. But, I would reply, the very fact that those writers engage in such discourse undermines their own contention; they ignore the evidence provided by their own actions. There is certainly meaning in the Universe to this degree: *the fact that they take the trouble to write such contentions is proof that*

they consider it meaningful to argue about such issues; this quality of existence has emerged out of the nature of the physical Universe. Indeed, the human mind is causally effective in the real physical world precisely through many activities motivated by meanings perceived by the human mind.

Any attempt to relate physics and cosmology to ultimate issues must take such real-world experience seriously; otherwise, it will simply be ignoring a large body of undeniable data. These data do not resolve the ultimate issues, but they do indicate dimensions of existence that indeed occur. I consider briefly here 2 types of such evidence that reinforce the arguments given above, namely, concerning experiences related to ethical issues and experiences that many interpret as related to a spiritual or transcendent existence.

The Nature of Ethics

A key area where human experiences are important is ethics and morality: the issue of how we ought to conduct our lives. The origin of moral values has been the subject of debate for centuries. I will just state my own view here and give some references to literature where it is supported. I take the position of moral realism, which argues that we do not invent ethics, but discover it: there is a standard of morality that exists (in "reality," just waiting to be discovered) that is valid in all times and places, and human moral life is a search to understand and implement that true nature of morality. Thus, I believe that *moral choices relate to ethical values that are timeless and culture independent*, and this is based in existence of a moral reality, as well as a physical reality and a mathematical reality, that underlies the Universe.

For detailed arguments in support of this contention, based in the idea that morality is real and so not just a social construction or evolutionary invention, see Murphy and Ellis (1995), Gaita (2004), and Ellis (2008a). The only point I would make here is the following: there is in fact tacit agreement with this position in the writings of both Richard Dawkins (2006) and Viktor Stenger (2007), for both make strong claims about the evil caused by religion. In doing so, they are presuming to make a claim that is more than just their personal opinion: they are expressing this as irrefutable fact. Indeed, Stenger claims (p. 216) that it is a scientific fact that evil exists. So what is the experiment that establishes this as a *scientific* fact? There is none, as science does not comprehend the concepts of "right" and "wrong"; there are no scientific units ("milli-Hitlers") for degrees of evil. This is an ethical claim falsely dressed up as science. But the point is that this argument by both Dawkins and Stenger does show a belief in absolute standards of right and wrong, independent of culture and space and time, which is in agreement with my own position that underlying the Universe is a moral reality. We can then add to the 4 Worlds listed above in "The Nature of Existence" another one:

World 5 is the world of Platonic ethical forms, providing a foundation for our sense of ethics. This is perhaps related to a sense of beauty and aesthetics, and it is certainly linked to and based in concepts of purpose and meaning *(telos),* for these are what underlie ethical behavior.

Then the family of worlds we need to recognize becomes as shown in Table 24.6.

The core of being is then, in this view, the underlying ultimate purpose relating to meaning and morality. One can argue that this purpose, as identified by the spiritual traditions of all the major

TABLE 24.6
The Different Kinds of Reality Enhanced by a Layer Representing Ethical Values and Meaning

- *World 1:* Matter and Forces
- *World 2:* Consciousness
- *World 3:* Physical and Biological Possibilities
- *World 4:* Abstract (Platonic) Reality
- *World 5:* Telos—Ethical Reality Related to Purpose

world religions, is unselfish love, or *agape*. The kind of ethics that is compatible with this view is *kenotic* (self-emptying or purgative), invoking a loving attitude and respect for the freedom and integrity of others as a basic principle underlying the nature of existence, extending to sacrificing on their behalf, a free and willing gift when this has the effect of transforming the situation to a higher ethical level (Ellis, 1993, 2008a; Murphy and Ellis, 1995).

This quality of existence, whose transforming nature has a self-authenticating quality when experienced, is then seen, in this viewpoint, as the ultimate purpose of the whole, enabled by the nature of the laws of physics and the boundary conditions for the Universe that are set so as to make this possible, and indeed requiring that they be this way in order that these purposes can be realized (Ellis, 1993). The core of being, and its ultimate purpose, is then the possibility and the demonstration of caring love for others, as many religious standpoints have proclaimed; this is what leads to and underlies the nature of existence. The material is the vehicle by which this is made possible.

Experiences of the Transcendent

For many, a deeply religious worldview is crucial in understanding our lives and setting values, this worldview being based in our personal life experience, including our experience of a faith tradition and community, religious texts, and inspiring leaders. All of these are data that help us understand our situation and our lives, but their nature and significance are strongly contested by those with other beliefs. My focus here is on what I call "intimations of transcendence": significant experiences in the lives of many people that reinforce the worldview proposed above. They suggest that there is a copious abundance of being, a plenitude that is more than is necessary, underlying the reality of physical existence. This extra dimension of existence, which we sometimes can glimpse in fleeting ways, is in fact an experience of transcendence. I give a number of examples:

> I say to myself as I watch the niece, who is very beautiful: in her this bread is transmuted into melancholy grace. Into modesty, into a gentleness without words. ... Sensing my gaze, she raised her eyes towards mine, and seemed to smile. ... A mere breath on the delicate face of the waters, but an affecting vision. ... I sense the mysterious presence of the soul that is unique to this place. It fills me with peace, and my mind with the words: "This is the peace of silent realms." I have seen the shining light that is born of the wheat. (From *Flight to Arras*, by Antoine de St. Exupéry, 1969)
>
> One day during my last term at school I walked out alone in the evening and heard the birds singing in the full chorus of song, which can only be heard at that time of year at dawn or sunset. I remember now the shock of surprise with which the sound broke upon my ears. It seemed to me that I had never heard the birds singing before and I wondered whether they sang like this all year round and I had never noticed it. As I walked I came upon some hawthorn trees in full bloom and again I thought that I had never seen such a sight or experienced such sweetness before. I came then to where the sun was setting over the playing fields. A lark rose suddenly from the ground beside the tree where I was standing and poured out its song above my head, and then sank still singing to rest. Everything then grew still as the sunset faded and the veil of dusk began to cover the earth. I remember now the feeling of awe which came over me. I felt inclined to kneel on the ground, as though I had been standing in the presence of an angel; and I hardly dared to look at the face of the sky, because it seemed as though it was but a veil before the face of God. (Bede Griffiths, quoted in Taylor, 2007, as quoted in Bellah, 2008)
>
> I call to mind that distant moment in [the prison at] Hermanice when on a hot, cloudless summer day, I sat on a pile of rusty iron and gazed into the crown of an enormous tree that stretched, with dignified repose, up and over all the fences, wires, bars, and watchtowers that separated me from it. As I watched the imperceptible trembling of its leaves against an endless sky, I was overcome by a sensation that is difficult to describe: all at once, I seemed to rise above all the coordinates of my momentary existence in the world into a kind of state outside of time in which all the beautiful things I had ever seen and experienced existed in a total "copresent"; I felt a sense of reconciliation, indeed of an almost gentle consent to the inevitable course of things as revealed to me now, and this combined with a carefree determination to face what had to be faced. A profound amazement at the sovereignty of Being became a dizzying sensation of tumbling endlessly into the abyss of its mystery; an unbounded joy at being alive, at having been given the chance to live through all I have lived through, and at the fact that

> everything has a deep and obvious meaning—this joy formed a strange alliance in me with a vague horror at the inapprehensibility and unattainability of everything I was so close to in that moment, standing at the very edge of the "finite"; I was flooded with a sense of ultimate happiness and harmony with the world and with myself, with that moment, with all the moments I could call up, and with everything invisible that lies behind it and has meaning. I would even say that I was "struck by love," though I don't know precisely for whom or what. (Vaclav Havel, quoted in Bellah, 2008)
>
> Perhaps more wonderful still is the way in which beauty breaks through. It breaks through not only at a few highly organised points, it breaks through almost everywhere. Even the minutest things reveal it as well as do the sublimest things, like the stars. Whatever one sees through the microscope, a bit of mould for example, is charged with beauty. Everything from a dewdrop to Mount Shasta is the bearer of beauty. And yet beauty has no function, no utility. Its value is intrinsic, not extrinsic. It is its own excuse for being. It greases no wheels, it bakes no puddings. It is a gift of sheer grace, a gratuitous largesse. It must imply behind things a Spirit that enjoys beauty for its own sake and that floods the world everywhere with it. Wherever it can break through, it does break through, and our joy in it shows that we are in some sense kindred to the giver and receiver. (Rufus Jones, 1920)
>
> I believe with all my heart and mind that there is a spiritual dimension to all being that cannot be encapsulated in scripture or in creed; an essence that loses its creative force when its communication depends upon the use of words alone. It can I think be readily made manifest through metaphor in poem or story; yet I am deeply aware that even when presented in such a form the truth remains partial. For me, there is a reality that lies beyond our presently misdirected concern for the fruits of economic power. It is only when we acknowledge our deeper inner urge to discover meaning in existence that we begin to harvest the fruits of the spirit. Most of us are at least partially aware of epiphanies that come our way from time to time: the emergence when rounding a corner of a breathtaking panorama of mountain, forest and ocean; the sudden sensibility of a zephyr breeze rustling treetops; the scent of jasmine on a shower of rain. I believe there are illuminations far beyond these: intuitions, insights, divinations that are not shaped by the physical senses; the hand of a friend on one's shoulder in a time of trouble; the sudden recognition of a smile in a passing stranger; above all, the wondrous inspiration of the serendipity, synchronicity, and innate knowing in the fabric of our lives. More often than not gifts such as these, which indelibly inscribe themselves upon our memories, are regarded as gifts of God. (Lewis Watling, 2006)

Bernard d'Espagnat, winner of the 2009 Templeton Prize, said in an interview that science has helped him to "justify his impression of a link between beauty and the divine."* He explained: "When we hear great classical music or look at very great paintings, they are not just illusions but could be a revelation of something fundamental. I would accept calling it God or divine or godhead but with the restriction that it cannot be conceptualised for the very reason that this ultimate reality is beyond any concept that we can construct." That is a view I would concur with; it is elaborated in Ellis (2008a).

The Weight of Evidence

What does this all add up to? First, even in order to understand just the material world, it can be claimed that one needs to consider forms of existence other than the material only—for example, a Platonic world of mathematics, on the one hand, and a mental world, on the other, both of which can be claimed to exist and to be causally effective in terms of affecting the material. Our understanding of causation will be incomplete unless we take them into account. The fact that they exist shows that there is more to existence than just material things: as argued above, other kinds of things exist and have real causal powers.

Second, there are also extraordinary qualities of life, including purpose, ethics, aesthetics, and meaning. These certainly exist, but what is the ground of their existence? The possibility space arising out of the fundamental laws of existence must in some sense have these things built into it, for they certainly have come into existence. *And they can have the transcendent quality I have*

* See: http://www.templeton.org/templeton_report/20090415/; also see http://www.timesonline.co.uk/tol/comment/faith/article5918050.ece.

indicated through the quotations above. The fact that such a quality can exist is itself a statement about the nature of reality. In brief, *ex nihilo nihil fit*: the possibility of meaning and ethics cannot arise out of genuine chaos or out of literally nothing; it has to have been built into the foundations that gave physical existence its structure.

In my view, they represent the ultimate nature of reality because it is extraordinarily unlikely that they could have this nature, this quality of existence, by pure happenstance. Invoking a Multiverse of necessity simply postpones facing the ultimate questions: how can such qualities come into being if they do not represent something about the nature of reality, something that even preexisted the existence of the Universe itself—just like the laws of physics, which are themselves abstract rather than physical entities?

THE NATURE OF THE ARGUMENT

So is the ultimate reason underlying the lowest-level laws on which everything else is based pure chance, probability, necessity, or purpose? They are all logically possible. Neither science nor philosophy can give a certain answer as to which is the deep underlying cause of things: metaphysical uncertainty remains (Ellis, 2006). However, if one wants to relate one's understanding to the deeper meaning of personal life, the last option has the most traction. The others in the end provide a more tentative relation to morality and meaning, although experience suggests that these exist.

This view cannot be *proved* to be true, but it is supported by much experience that has considerable persuasive power as a whole. We should take into account data from the whole of life, not just physics or astronomy: we are part of the Universe and live in it. When dealing with ultimate meaning, what is relevant is whatever seems to give ultimate meaning in human life. There is indeed purpose in the Universe (for example, we gathered in Beijing to understand its nature a bit better[*]). Either purpose emerges out of nothing, or it is there from the start as the foundation, then being reflected in life. The latter is indeed a possibility for the nature of ultimate causation and the underlying reason for why the laws of physics exist and are as they are (Ellis, 1993, 2008a; Murphy and Ellis 1995). This can provide a satisfying explanation for the full depth of life and human experience, in contrast to reductionist materialist explanations that explicitly or implicitly deny the full depth and reality of this profound experience.

Finally, it should be emphasized that this is not a scientific conclusion, nor is the argument presented one that can be sustained on scientific grounds alone; it is a philosophically based conclusion. The issues considered here (the nature of ultimate causation) are not amenable to scientific resolution, precisely because they go beyond the domain where scientific experiments or observations can give a reliable answer. The argument is thus a philosophical or metaphysical one, based securely on current science, but also taking into account wider philosophical and human issues than cannot be handled by science *per se*. Any attempt to adequately tackle the fundamental issues considered here will necessarily be of this nature. If one wishes to deal purely in terms of scientific argumentation, then the above will be beyond what one will consider as legitimate argument. But if one takes that stand, allowing scientifically rigorous explanation alone, one should also carefully refrain from making any statements about issues of ultimate causation, except if they are identified as purely the personal opinion of whoever is making the statement, and without any scientific standing.

I apologize here for not giving references to all the other books and articles that look at these issues and come to the same kind of conclusions: space simply does not allow this. To pursue things further, one can read the works of Ian Barbour, Arthur Peacocke, John Polkinghorne, John Hick, Keith Ward, Holmes Rolston, Nancey Murphy, Philip Clayton, John Haught, and many others. My views have benefited from them all. As an entrance point to this large literature, see Clayton and Simpson (2008).

[*] For the *New Vision 400* conference: http://nv400.uchicago.edu/.

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