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Steps to a Metaphysics of Incompleteness

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> We are what we are not: continually, intrinsically, necessarily incomplete in our very nature.
> Deacon, *Incomplete Nature* (2012), 535

Introduction

There is no explicit attempt to develop a metaphysical foundation for the theoretical positions presented in the book *Incomplete Nature* (Deacon 2012) or in the many papers elaborating ideas related to its core theses. However, the quite atypical approach this work takes to the concepts of emergence, teleology, information, and sentience sharply contrasts with the currently dominant mechanistic metaphysics that dates to Descartes and other enlightenment thinkers, and yet also contrasts with current alternative vitalist, pan-experientialist, theological, and process-metaphysics perspectives as well. This begs for a serious reconsideration of the metaphysical assumptions that are thereby challenged. Although the scientific claims made concerning the origins of living and semiotic processes are ultimately subject to empirical testing, the deeper assumptions concerning the ontological status of autonomous agency and "strong" emergence require consideration in light of the larger history of metaphysical reflection, including both ancient and modern spiritual traditions.

A central claim of the theory outlined in *Incomplete Nature* is that meaningful relationships and purposive processes are not incompatible with physical relationships and dynamical processes, and thus are neither epiphenomenal illusions nor influences from a separate non-physical realm. But neither are they identical with and reducible to simple physical-chemical processes. The approach outlined in this work suggests instead that the apparent incompatibility between teleological and mechanical causality reflects a default tendency to consider only tangible substance to be real and to ignore the necessary complementary reality of its now absent attributes or future potentials. In other words, material phenomena are presumed to constitute the realm of being while all else is categorized as non-being. This has made it appear that teleological dispositions, because they are inclinings toward a currently non-existing state of things, lack physicality. Unfortunately, this implies that experience of personal conscious agency also lacks physical existence, and is either illusory or requires a kind of non-physical mode of being. We argue, what is *specifically absent* plays a fundamental role in the dispositions exhibited in material-energetic processes. This implies that the default substance metaphysical assumption and the dualism or eliminativism that appear to be the only options it allows, may be in need of reconsideration and revision.

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Although in many respects the questions explored by science and metaphysics are framed differently—science concerned with the determinate relations between things we can observe, and metaphysics concerned with assumptions about the nature of their existence—these interests cannot be entirely separated. New scientific discoveries have regularly brought into question some of the most fundamental assumptions about what exists. Discovering that the physical world is vastly larger, more complex, and more strange than what could have been conceived just a century ago has spawned doubts about the adequacy of some of the most unquestioned axial-age assumptions. But this is not merely a problem that requires a change in metaphysical commitment. In many respects, the challenge is scientific. To rebuild a bridge between science and metaphysics will require a re-examination of a fundamental principle of empirical science: the exclusion of teleology. Advances in molecular biology and neuroscience may force us to confront scientific questions that appear to exceed the reach of this unexamined metaphysical assumption. These questions are the origins of life and the nature of conscious experience. To resolve these mysteries requires that we precisely define life and mind in ways that capture their more-than-material properties; properties that have long been treated as illegitimate topics for empirical science.

The methodological dualism that results, is not merely the invention of science, philosophy, and theology. In a paper titled "The Role of Symbolic Capacity in the Origins of Religion" (Deacon and Cashman 2009), we argued that there is a ubiquitous human tendency to tacitly assume a two-tiered ontology in which the world present to the senses is merely a diminished projection of a more real world of ultimate meanings and values. We argue that this is a consequence of the evolution of symbolic cognitive biases that lead us to intuitively see things as symbols, like words; physical artifacts that are the meager and imperfect exemplars for meanings hidden in the minds of others. Words and objects are physical; meanings and ideal forms are not. This default dualism has influenced all realms of practical and technical knowledge contributing to exclusionary monisms (e.g. idealism and eliminativism) as well as various dualisms (e.g. in both mystical and scientific paradigms).

In the following essay, we explore some implications of a possible alternative vision. We make no claim to have formulated a thoroughly novel metaphysical system, only to offer some speculations about how a third metaphysical perspective might differ from current metaphysical assumptions and parallel certain less well-known metaphysical traditions. In this exploration we interpret the title "Incomplete Nature" literally, to imply that the very nature of being involves fundamentally both presence and absence; positive as well as negative attributes. It is our speculation that living and mental phenomena are expressions of true ontological emergence from antecedent conditions lacking the existence of these attributes of being, and that this logically requires that the very nature of existence is in some sense fundamentally incomplete.

Section I

Ontological dependency

Science examines the observable universe and asks the question: How does it work? It is concerned with the causes of things that happen, what things are made of and their structure. It is an effort to understand why events in the universe happen the way they do.

Success in science is measured by whether or not we can reliably make accurate predictions. Metaphysics is concerned with being, reality, and with the ontological status of what is really out there (and in here), irrespective of how we might experience it or what we can know about it.

In particular, metaphysics is concerned with dependency. Over the centuries, Western metaphysicians have been concerned with determining what exists independently versus what is dependent. And almost uniformly, these philosophers have privileged independent being: that which *is* irrespective of the being of anything else.

According to traditional interpretations of Parmenides, Plato, and Aristotle attempted to determine what is required for something to have independent being. They determined that it was essence, the pure form of *what* it is to be something: *to ti ên einai*.

For Parmenides, only that which is pure being—that is, being *simpliciter*—can be. That which is susceptible to change therefore lacks pure being. He argued that there can be no amalgam with non-being, no lesser being, because there can be no non-being; everything that is, *is* being. Thus there is only being, and no dependency on it. Of course, this leaves the evidence for change illusory.

Plato attempts to resolve this by separating the forms of things from the temporal imperfect embodiments of the forms. In Plato's world of ideal forms, *eidoi*, the forms are independent in being. They exist *simpliciter* and therefore do not change. But in the changeable world of sensed objects, the fleeting forms things assume reflect only imperfectly the true being of the ideal forms. So the forms are simple and unchanging while their imperfect embodiments are *dependent* upon these pure forms, and thus are not the really real.

Aristotle was not so willing to relegate the physical world to dependent being and to treat the abstract as more real than the concrete. He argued instead that what was ontologically independent was substance. Substance is a combination of matter and form. Substance can have independent being because it necessarily involves an essential form. Forms don't exist apart from their material embodiment and nothing can be substantial without exhibiting some form. Accidents also take their being from substance, and are entirely dependent on it for their being. If the substance in which they inhere were to disappear, so too would the accidents.

As the pagan Greek philosophy gave way to Hebrew, Christian, and Muslim theologies, the notion of a willful Creator God who is self-existent and upon whom all created things depend became the common understanding of metaphysics in the West. In many respects, each of the theologies came to exemplify some version of the Platonic notion that all earthly being is dependent being— depending for its being on that which is nonmaterial, timeless, and perfectly simple. Many centuries later, influenced by the rediscovery of Aristotle's works, Thomas Aquinas provided a more subtle distinction between being and existing, shifting the notion of that which is independent from unchanging essence to actual existence. Being, he claimed, does not derive from unchanging form, but is due to an act of existing, an *esse*. God's being is to be understood as independent and eternal because He is not a combination of an essence and an act of existence, as are all of His creatures. God's essence *is* His *esse*. He is independent because He is uncomposed. Aquinas claimed that God's essence is *to be*: Yahweh, "I Am Who Am."

However, both the Platonic/Aristotelian *eidos* metaphysic and the Thomistic *esse* metaphysic offered a clear distinction between a being that is in some way *absolute* and

independent of anything else and one that is *contingent*, ultimately dependent on that absolute. Those of us who inherit the Greek way of thinking can hardly imagine explaining dependent beings in terms of other dependent beings, whose being, in turn, would then depend on other dependent beings and so on, *ad infinitum*. To prevent such a regress, it would seem there has to be an Absolute Independent Being that terminates any chain of contingent dependencies on dependencies, something whose being is complete in itself. It nevertheless appears that three great and very early thinkers *did* think of being in such interdependent terms.

Three outliers

Among the major philosophers and religious thinkers of the ancient world, three dissenters from this view—all living somewhere between the fourth and sixth centuries BC—anticipated many aspects of a metaphysics of incompleteness. They are Heraclitus in the Greek-speaking world; Gautama, the Buddha, in the Indian world; and Lao Tzu in ancient China. Ontology was not their primary concern, and yet for each, ontological issues were clearly addressed.

Heraclitus

Most accounts of Heraclitus, ancient and modern, focus on his view of incessant change and impermanence. Parmenides claimed that the simplicity of Being makes motion and change impossible, and therefore illusory. Heraclitus claimed that everything is in motion all the time—*panta rei*, everything is flowing. Although all but the merest fragments of his work are lost, we can discern an important counter-theme present in the fragments of his work that we do have. Heraclitus knew that not all things are in flux just like a constantly flowing river. Plants, animals, and people constantly change, but in many ways they also seem to remain stable. It is likely that he was referring to this apparent stability in his fragments on the "war of opposites," which can create a *harmonia*—an agreement. Heraclitus is quoted: "They do not grasp how by being at variance it agrees with itself, a backward turning adjustment (or, an adjustment of opposite tensions; *trans.*) like that of the bow or lyre" (Guthrie 1962, 439, Fr. 51).

The wood of the bow is held bent backwards by the bowstring. The string is stretched by the bow, and the bow is bent by the string. They are in equal and opposite tensions, and thus the whole seems stable and unchanging even though it is in a constant struggle. So, too, a lyre with its stretched strings is maintained in tension. The two countervailing forces give rise to a potential for activity that neither part contains or can contribute by itself. The bow and string, as a result of their internal countervailing forces can shoot an arrow a hundred yards. The lyre can fill a room with music. So, two quite specific potencies to initiate change are held ready to constrain and direct new work due to this tension.

In another fragment, Heraclitus writes about the *kykeon*—a well-known drink in Greece from Homer's time (Figure 1). The *kykeon* (from the Greek "to mix or stir") is "made by taking a cup of wine and stirring into it barley and grated cheese. These of course would not dissolve, so that the mixture had to be kept in motion until the moment it was drunk" (Guthrie 1962, 449). Heraclitus notes, "The *kykeon* falls apart if it is not stirred" (Guthrie 1962, 449, Fr. 125). Guthrie says, "Kirk's comment on this fragment cannot be improved on: 'The fragment is of greater importance than it first appears:

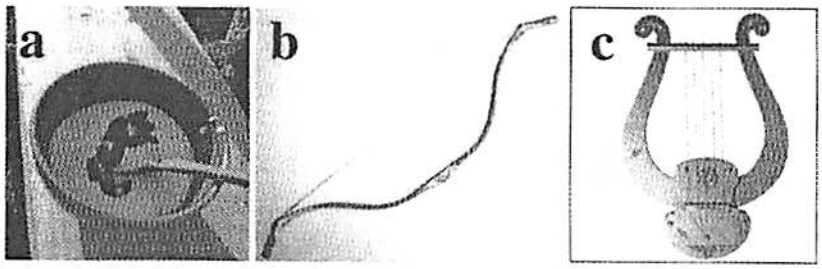

Figure 1. The *kykeon* drink (a), a strung bow (b), a lyre (c).

it is the only direct quotation that asserts, even though only in an image (but this was Heraclitus' declared way of announcing the most fundamental truths) the consequences of an interruption in the reciprocity of opposites'" (Kirk 1954, 255f).

The major modern commentators on Heraclitus—W.K.C. Guthrie and G.S. Kirk—agree on the centrality of these two fragments in Heraclitus' understanding of reality. And the upshot is that Heraclitus, even though very early in the unfolding of Greek thought, quite likely held surprisingly sophisticated metaphysical views. We are only now coming to similar conclusions about the reality of matter and form in the physical and biological worlds.

The Buddha

Siddhartha Gautama either denied or set aside as unimportant some of the fundamental metaphysical assumptions of the vast Hindu tradition he inherited.

The central understanding of the spiritual metaphysics of Hinduism is that there is an Absolute Being, Absolute Consciousness, Absolute Bliss. This Absolute is called Brahman. Connected with this doctrine is the claim that the individual human soul, each person's own *atman*, is also ontologically this same Absolute Unchangeable Being. Such a dramatic claim leads to a puzzle similar to that Parmenides was faced with: What then is the reality of the changing, interdependent and contingent world of our experience? It must be, in some deep sense, illusory. My conviction about myself and the world around me as contingent and dependent and changing through time is considered a sort of existential amnesia.

It is this classic teaching of Absolute Being and the *atman* that the Buddha doubted. He did not doubt that each human being is an individual self or a person. He doubted that at the core of each human being is an *atman*, something (someone) understood to be the same as the Divine, Absolute Being. When the Pali and Sanskrit Buddhist texts are translated into English, the term "*anatman*" (no *atman*) is usually translated as "no self." The three fundamental understandings of Buddhism are, thus: "life is suffering; everything is impermanent; and there is no self." Centuries later, in the Prajñāpāramitā Sutras, the understanding of *anatman* is expanded to all of reality, so that all things are claimed to be *empty*. Empty of what? Empty of *svabhāva*, own-being. To have "own-being" would mean to *be* in a non-dependent, self-sufficient way. One's *being* in this case would not be derivative or dependent on anything else (see Walshe 1987, 73–75, paras 1.30–1.35).

Along with the three negatively stated principles of impermanence, suffering, and no-self is the tradition's positive claim that the *being* of everything is the result of

pratītya-samutpāda. This phrase can be translated as "interdependent co-origination." When the Buddha taught this doctrine, he was addressing the issue of ontology: What then is the *being* of the world we encounter? What is real? How did living beings, for example, come to exist and be the way they are?

Gautama was not primarily a metaphysician. His explanation of the metaphysics of *the real* is not offered for its own sake, nor to solve an intellectual conundrum. His primary, and almost sole, concern is suffering. He observed that everywhere, human life is characterized by suffering. The ultimate reason for this, he observed, is a set of faulty metaphysical/ontological assumptions that are commonly held by everyone.

In an earlier paper (Deacon and Cashman 2009), we explained that human beings, as the symbolic species, have a tendency to believe in and look for an Ultimate Ground of being and meaning. This is the default metaphysical position of our minds. It is what supports the nearly universal cross-cultural assumption that we live in a bi-layered world—one meaningless, imperfect, and material and the other meaningful, perfect, and formal.

Buddhist meditative practice has as one of its effects the undermining of that default assumption, allowing the breakthrough realization that everything we see and touch and can know about is ultimately impermanent. Once that species-specific default assumption is clearly *seen* as illusory, our congenital tendency to cling to what we love and to resist what we dislike relaxes. And the extraordinary beauty of this ever-changing world heaves into view.

Gautama did not indicate exactly *how* the interdependent co-origination works that brings about the reality we observe. What he claimed was only that the fact was available to us empirically through the observation of our own interior and exterior experiences. Still, metaphysically, the idea is deeply counterintuitive. How could it be the case that plants, animals and humans come *to be* entirely by the interaction of dependent elements, which are contingent on each other? Where is the ontological ground that they rest on? Rather than identifying some ultimate absolute from which all contingent being springs, and upon which it depends, the Buddhist insight into emptiness reveals that relational, interdependent being is primary.

We, the authors of this paper, are convinced that *inter*dependence and *co*-origination are just the point. A metaphysics of strong emergence of life and mind is possible through interdependent co-origination as long as the relevant dependent forms of being can interact with each other in such a way that they each prevent the other from going out of existence.

Lao Tzu

The *Tao Te Ching*, attributed to the Taoist sage Lao Tzu and probably written during the fourth century BC, provides one of the most cryptic accounts of a metaphysics that attributes equal relevance to the present and absent aspects of things. Unlike the Hindu and Buddhist traditions, it almost entirely ignores addressing issues of subjectivity and spiritual being, and instead focuses on developing an understanding of the logic of natural processes that can inform appropriate action. It is in the section describing the Tao (sometimes translated as "the way" or "harmonious path" or "natural order") that hints to its metaphysical foundation are addressed. It entails a recognition of two intrinsic aspects of all forms of being: *yin*, the passive, yielding, absent, "feminine" aspect; and *yang*, the active, forceful, substantial, "masculine" aspect. Thus, the complementary

passive/active, yielding/forceful, absent/present features of natural processes and human actions are highlighted. Verse 2, line 1, explicitly invokes "The mutual production of being and non-being"—an almost literal statement of intrinsically dependent being. But perhaps the most directly relevant verse (number 11) was quoted as the epigraph to chapter 1 of *Incomplete Nature*. It poetically encapsulates the essence of the core thesis of the book. It is rendered (not a literal translation) there as follows:

> Thirty spokes converge at the wheel's hub, to a hole that allows it to turn.
> Clay is shaped into a vessel, to enclose an emptiness that can be filled.
> Doors and windows are cut into walls, to provide access to their protection.
> Though we can only work with what is there, use comes from what is not there.

Below, we will return to analyze various aspects of this verse and why it metaphorically exemplifies the essence of the theory; but here, it is relevant to notice how each of the examples used—a wheel, a vessel, a wall—is defined both with respect to something present (*yang*) and something absent (*yin*), and how both aspects are necessary complements that provide for usefulness (which is also not an intrinsic attribute). The property that in *Incomplete Nature* is sometimes described as being "absential" or a "constitutive absence" is also echoed in the Taoist conception of the feminine (*yin*) principle. For example, in verse 6 we find the following description:

> The valley spirit never dies.
> ... the mysterious female
> ... It seems to exist.
> In being used, it is not exhausted.

Again, the reference to "being used" brings into focus the existence of that which offers a potential that cannot be used up. The relevance of this to constitutive absence (as is also exemplified in verse 11, above) can, for example, be demonstrated by the referential function of words. Because the meaning of a sentence exists only intentionally, but not as a physically present object or force, it cannot be exhausted by use and can be handed from one form to another without diminution—as when a spoken idea is transferred to electric signals, and electric signals to written text, and written text to neural activity patterns, in another's brain.

So each of these three ancient outliers provide conceptions of being that recognize both a positive and negative aspect to being and deny the possibility of absolute non-relational being.

The alienation

In the last few hundred years, we in the West have experienced a growing intellectual split between science and theology as well as between natural science and the humanities. This is in large part because the Abrahamic religions that dominate the West and the Middle East do not coexist easily with the metaphysical assumptions underlying the natural sciences. Ever since the days when Copernicus and Galileo dismantled the 1000-year-old geocentric paradigm of Ptolemy and when Giordano Bruno was burned at the stake for the heresy of challenging core theological assumptions and predicting the existence of multiple peopled worlds in an infinite cosmos, the natural sciences and the Western

theologies have been uneasy with each other. Mutual suspicion and fear continues in many quarters to this day.

But it was not always so. During the early thirteenth century in Europe, philosopher-theologians investigated and taught a sophisticated natural philosophy and science that fit harmoniously with theology and religious understanding. This era in Europe grew out of the work of Islamic theologians and scientists, great investigators and thinkers, in Damascus, Bagdad, Persia, and southern Spain beginning in the tenth century; and their preservation and reflections on the works of Aristotle and other seminal Greek thinkers, whose works had been lost to European scholars.

During the subsequent centuries in Europe, the harmony between theology and science began to fall apart, due largely to a small shift of theological emphasis that, over time, had tectonic consequences.

In the late thirteenth and early fourteenth centuries, there was a new emphasis on God's absolute freedom in the act of creation—as a result of his omnipotence. This undermined the classical Platonic/Aristotelian understanding of

> science conceived as necessary knowledge of things that could not be otherwise and thus could be known in their essence.
>
> For, beginning with Duns Scotus and culminating in Ockham, the very definition of knowledge was transformed. In effect, recourse to God's omnipotence cut nature free to be taken as given, "positive" in the sense of posited by God's will, and with Ockham this came to mean free not only from Arabic-Aristotelian determinism but also from the hypostatized ontological categories of Greek rationalism. (Barnouw 1981, 608)

Gordon Leff (1976, 15) observes the result of this new emphasis in similar terms:

> Once the exclusively individual nature of existence or the unattainability of universal being was accepted, the world became at once a more knowable and a less perplexing place. The ingenuity that had for so long been expended upon reconciling individuals with their universal natures could instead be redirected to exhibiting ways in which singular things can be described by universal words.

This shift in the conception of God's power opened a path for modern empirical science that was not to be clearly described until 300 years later, by Francis Bacon. At the same time this tectonic shift prepared the way for a more Scripture-based theology that would not flower until the printing press put bibles in the hands of the congregation.

Already in the early fourteenth century, William of Ockham could write:

> [O]nly faith gives us access to theological truths. The ways of God are not open to reason, for God has freely chosen to create a world and establish a way of salvation apart from any necessary laws that human logic or rationality can uncover. (Irvin and Sunquist 2001, 434)

By the middle of the seventeenth century, the new understandings that both theology and science had developed appeared to be irresolvably different. Proponents of the early natural science also began pulling away from scriptural accounts of nature as well as from Aristotle's understanding of final causality and the unifying vision that it seemed to provide for theology and natural philosophy. Instead, they began putting their faith in direct empirical investigations of nature. Thinkers like Brahe, Bacon, Galileo, Kepler, and Newton also began relying on systematic observation to identify general regularities of nature that could replace divine teleological explanations with formal quantitative

laws. This rift was solidified by methodological principles articulated by some of the most illustrious thinkers of the European enlightenment. This was, in part, a calculated distancing from the metaphysical assumptions of divine purposive conceptions of causality that characterized much of medieval philosophy. But it was also based on a pragmatic maxim that has shown itself to be highly productive. This operating assumption was perhaps most clearly articulated by René Descartes' assumption that any physical process can be completely explainable in the same terms as would be used to analyze the operation of a machine.

At the dawn of the scientific era, key enlightenment thinkers adopted a methodological stance concerning questions of purpose, meaning, and value. It was determined that these were issues not susceptible to empirical explanation and which were therefore outside the purview of scientific investigation. The major contributors to this metaphysical shift—Bacon, Spinoza, Descartes, Hobbes, and many others—sought a natural philosophy that was internally consistent without the need to rely on a quasi-mentalistic foundation to explain the order of things. Descartes' masterful effort to identify the radical incompatibility of these two modes of causality, while at the same time preserving the ontological status of each, exemplified this difference in terms of extension in space and time. Physical processes were characterized by determinate location and extension and constituted an ontological realm he thereby termed *res extensa*. This is the world of mechanism.

In René Descartes' *Treatise of Man* (1664), he enigmatically describes human physiology in terms of an automaton. In this way he implicitly suggested that organisms *are* in fact machines, not merely resembling machines. All of a body's actions were presumed to be the results of matter in motion. In this account the design and purposeful actions of its mechanisms, like those of any manmade device, were presumed to be attributes imposed from outside the mechanism itself. This didn't just include its physical design, but also the functional ends that the machine was employed to produce.

Mental processes, in contrast, seemed not to be definitively locatable, nor could their spatial-temporal dimensionality be specified. It appeared to be an ontological realm lacking clear extension that he termed *res cogitans*; the realm of the mental and purposeful. This basis for distinguishing what appeared to be incommensurable modes of being posed a dilemma that Descartes tried to resolve: How can an extensionless mode of being affect the causality of extended beings?

Framing the question in these terms seemed to place the issue beyond empirical investigation, since by assumption all empirical phenomena are presumed to be extended in space and time. But this hasn't impeded efforts to articulate a metaphysical resolution. Attempts to address this dilemma have ramified into many diverse areas of philosophy and science. In the time since Descartes' first interactionist proposal involving "communication" between these realms via the pineal body of the brain, subsequent proposals have largely fallen into four major categories. There are two dualistic options—interaction or dual aspect theories; and two monistic options—eliminating one or the other side of the dilemma. All four approaches still find contemporary exemplars, though surprisingly these accounts don't divide neatly between scientists and non-scientists.

In many respects, the physical sciences have adopted the methodological assumption that teleological properties are epiphenomenal and are descriptive heuristics that can ultimately be eliminated as science advances and replaces them with mechanistic accounts. In

contrast, the social sciences and humanities effectively treat teleological relationships as simply given, and generally assume that they cannot be reduced to simple mechanisms. This disjunction is indirectly reflected in arguments initially articulated by David Hume (1738–1740) and later developed by G.E. Moore (1903) demonstrating that statements about value can't be derived from statements of fact, and in C.P. Snow's "two cultures" impasse (Snow 1959) that still separates the natural sciences from the social sciences and humanities.

Biology occupies a sort of middle ground in which it is possible to take either stance. Thus cellular and molecular research can provide detailed studies of the operation of "molecular machines," whereas organismic and evolutionary biologists can analyze the many levels of adaptation by which organisms maintain themselves in order to persist long enough to reproduce. Nevertheless, when pressed, most biologists turn to the neutral terminology of *teleonomy* to describe "apparent" end-directed behavior and assume that teleological processes were shown to be irrelevant for evolution.

One of the most illustrious interactionists of the twentieth century was the Nobel Prize–winning neurophysiologist Sir John Eccles. In a book-length dialogue with Karl Popper (Popper and Eccles 1977), he argued that the left cerebral hemisphere of the human brain contains structures that collectively he called the liaison brain. The liaison brain was claimed to provide a link between a disembodied mind and its physical brain. Ultimately, this just replaces the pineal body in Descartes' speculation with a different set of brain structures, but provides no greater insights concerning how they could be affected by a disembodied self. Probably the most popular modern version of interactionism, however, derives from an effort to explain consciousness using quantum theory. In what is currently the most influential quantum theory of consciousness, Stuart Hameroff and Roger Penrose (1996) argue that the differential modifications of microtubule formation in different regions within each neuron and distributed in the hundreds of millions of neurons throughout the cerebral cortex could be influenced by quantum-level coherence effects.

Quantum-theoretic approaches to consciousness also hint at a modern resolution of interactionist metaphysics with what is often termed dual aspect theory. Variations on this theme were articulated during the first half of the twentieth century by philosophers such as William James and Alfred North Whitehead, and have many modern proponents. Dual aspect theory offered an apparent resolution of interactionist difficulties by positing that all phenomena include both a subjective and objective, interior and exterior, mental and mechanistic, genetic and morphological aspect. Quantum phenomena provide a novel way to reframe these approaches. This is because quantum theory posits a necessary transition between two mutually exclusive but interdependent causal domains: the quantum and the classical. Quantum "strangeness," characterized by the superposition of mutually exclusive states and the existence of entangled states, violates simple spatial-temporal localization. So, by definition, it cannot be identified with the mechanistic domain that Descartes called *res extensa*. By default, then, these non-extended characteristics place quantum phenomena within Descartes' realm of *res cogitans*. Since a fundamental purpose of quantum mechanics is to describe precisely how interacting quantum phenomena give rise to the classical mechanistic properties exhibited by macroscopic material and energetic phenomena, the discipline appears to provide a parallel to the account of *res cogitans* influencing *res extensa*, while at the same time treating these as merely different levels of one physical reality.

Though it is seldom acknowledged, this resonance with the logic of Cartesian dualism almost certainly contributes to the intuition that consciousness might have a quantum explanation. The problem with this superficial parallelism is that the quantum properties that violate the excluded middle restrictions of classical mechanics do not actually correspond to the properties that Descartes identified with the realm of *res cogitans*, specifically mental and experiential phenomena. Quantum indeterminacy may be relevant to addressing the classic dilemma posed by the presumed incompatibility between determinism and free will. Recent findings from the theory of dynamical chaos have demonstrated that highly divergent consequences can result from nearly identical initial conditions. The ultimately indeterminate fluctuations that characterize subatomic events could thus potentially be amplified in this way (such as by chaotic neural dynamics) to produce highly unpredictable causal trajectories. However, these quantum properties provide no account of the teleological and experiential features that were the basis for Descartes' distinction. So although to account for the character of quantum phenomena is itself an important challenge for any modern metaphysics, the quantum-classical relation offers no new clues to the metaphysical status of living and mental teleology. This likely explains why many quantum consciousness theorists have turned to panpsychism to account for this property.

So in summary, since the renaissance the natural sciences have tacitly assumed what can be described as a machine metaphysics. And yet the undeniable teleological nature of human experience and conscious agency has resulted in a sort of methodological dualism in which we both must use teleological terminology while at the same time denying the ontological status of teleological phenomena. But this leaves us with an untenable metaphysical gulf that suggests that the most fundamental attribute of our existence is in some sense unreal. As the father of non-equilibrium thermodynamics Ilya Prigogine lamented, "We must understand our world in such a way that it will not be absurd to claim that it has produced us" (Authors' translation of a line from Prigogine and Stengers 1979, 278). If we are to find a way to redeem science so that it explains rather than pretending to explain away the reality of lives and minds and the subjectivities and values that indubitably exist, we need to dissolve this dilemma.

Section II

From the Cretan to Gödel

One of the most profound and unexpected discoveries of modern logic and mathematics was Kurt Gödel's proof that a formal system can be either internally consistent or complete, but not both. In many respects, it represents an awakening out of the enlightenment dream. This discovery was essentially the culminating development of the exploration of paradoxical relationships that began with the discovery of the Cretan Liar's Paradox in ancient Greece. Though told in different ways, the basic logic begins with the assumption that all Cretans are liars. So if a Cretan says "I am lying," he can't be lying—which means he is telling the truth that he is lying; but since he is a Cretan, he must be lying about this, and so on. A simpler version is the statement: "This statement is false." If the statement is true, then it is false; but if it is false, then it is true, and so on. Other more involved variants of self-undermining relationships have also been described over the years.

A famous example is a book with pages that each contain lists of some of the page numbers in that same book (see Figure 2). There will be pages where the list of page numbers includes the number of the page that the list occurs on, and pages with lists that don't include the number of that page. There can even be a page with all the page numbers of pages that also contain their own page number. But there can't be a page with a list of all and only the page numbers of pages in the book that don't include their own page number in the list. If that page doesn't list its own page number, then its list is incomplete; but if it does, then it is not a page with a list of all and only the page numbers of pages in the book that don't include their own page number. This analogy is probably closest to the logic of Gödel's proof, since the task is either incomplete or results in an error (inconsistency), as described below.

At the beginning of the twentieth century, the philosopher Bertrand Russell identified an analogous paradox at the heart of set theory and predicate logic. It is often characterized as "the class of all classes that are not member of themselves." As with the book analogy, if it is a member of itself, it can't be; but if it isn't, then it must be, and so on. Russell reasoned that one might evade this problem by simply prohibiting this sort of confusion of logical levels, which he defined as logical types. With this provision, he and Alfred North Whitehead produced a seemingly complete logical-mathematical formal system: the *Principia Mathematica* (1910–1913).

Enter Kurt Gödel. By devising an ingenious way of mapping formulas one-to-one onto a set of numbers, analogous to the page of page numbers example, he showed that such a

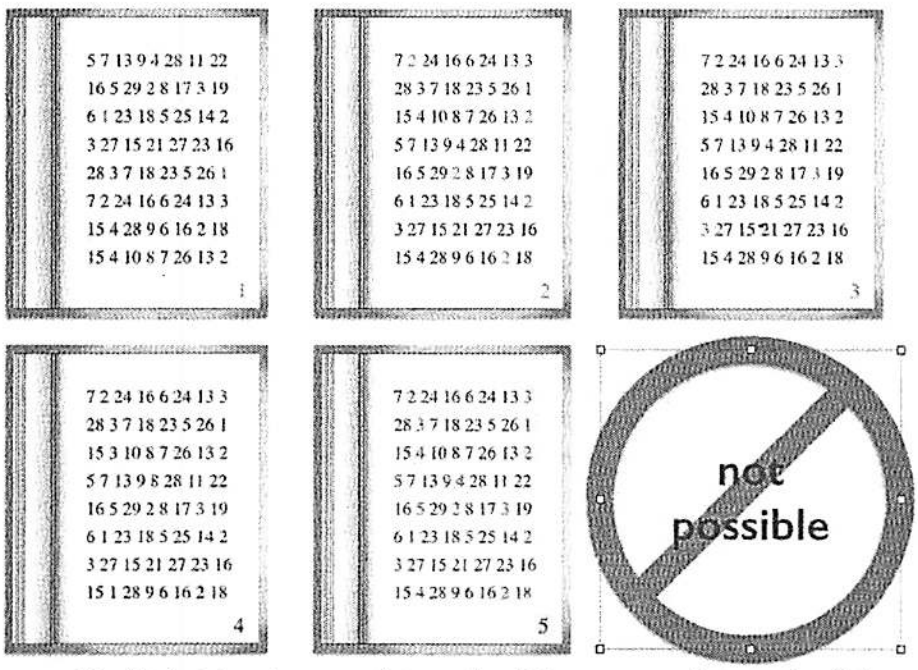

Figure 2. Depiction of the book of page numbers paradox.

mapping can be used to produce an unresolvable formula that can neither be proved nor disproved within that formal system. Like the book of page numbers, the entire formal system of *Principia Mathematica* or any similar formal system must either be unable to avoid inconsistencies or be incomplete.

The mathematician-computer scientist Douglas Hofstadter has made a career-long study of this sort of relationship, beginning with his award-winning book *Gödel, Escher, Bach* (1979). He describes such relationships as "strange loops" because of their intrinsically self-undermining nature.

A number of commentators, including the philosopher-logician George Spencer Brown and the anthropologist-systems theorist Gregory Bateson, reframed the liar's paradox dilemma as it might apply to real-world phenomena. Instead of being stymied by the undecidability of the logic, they focused on the very process of analyzing these relationships. The reason these are undecidable is that each time they are interpreted it changes the context in which they must be interpreted; and so one must inevitably alternate between true and false, included and excluded, consistent and inconsistent, etc. So, although there is no fixed logical, thus synchronic, status of the matter, the process of following these implicit injunctions results in a predictable pattern across time. In logic, the statement "if true, then false" is a contradiction. In space and time, "if on, then off" is an oscillation. Gregory Bateson likened this to a simple electric buzzer, such as the bell in old ringer telephones. The basic design (shown in Figure 3) involves a circuit that includes an electromagnet that, when supplied with current, attracts a metal bar that pulls it away from an electric contact; this breaks

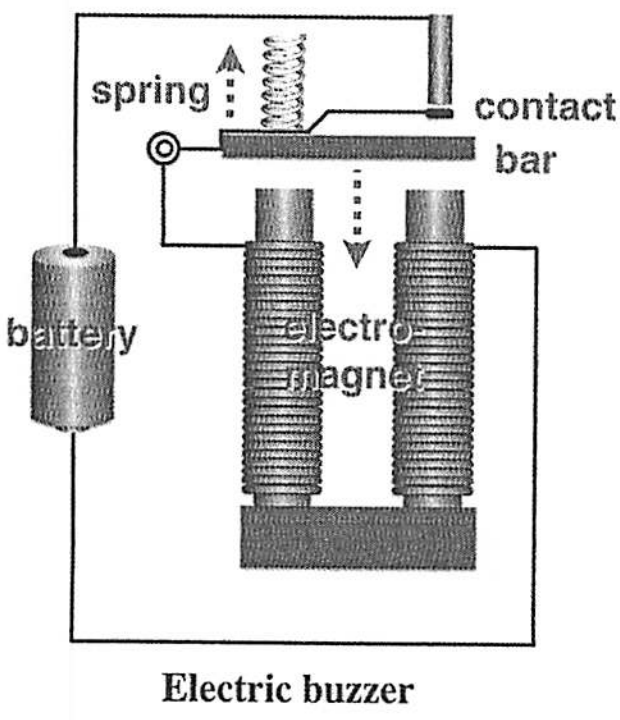

Figure 3. The organization of an electric buzzer. When the contact bar is pulled toward the contact by the spring, it completes the circuit; this activates the electromagnet, which then attracts the contact bar and breaks the circuit, shutting off the electromagnet—which then allows the spring to pull the contact bar toward the contact and thus reinitiates the whole cycle.

the circuit, cutting off the electricity to the electromagnet, which allows the metal bar to spring back into position where the electric contact re-closes the circuit, re-energizing the electromagnet, and so on. The resulting on-off/on-off activity is what produces a buzzing sound, or if attached to a small mallet can repeatedly ring a bell.

The critical insight provided in this physical framing of the paradox is that its logic requires—even "generates"—time, when physically realized. Its essential features make no sense without understanding the system's disposition to be in a different state at each future moment. Following Charles Sanders Peirce's conception of causality based on fundamental continuity—a concept he called *synechism*—we can thus say that this disposition to continue in this way exhibits a "habit" that has a mode of being *in futuro*. In other words, it cannot be fully described in synchronic or atemporal terms. Indeed, at any instant its present state is in the process of "absenting" its current condition. We argue that this is loosely parallel to the condition of being alive, except that instead of merely being organized to produce a future change of state, a living organism is organized to respond to the potential "absenting" of its own existence.

Autogenesis and teleodynamics

A core aim of *Incomplete Nature* is to demonstrate that teleological phenomena are as real and physical as are mass and energy. But to make this a scientific enterprise it is not helpful to simply assume that teleological properties are ubiquitous in nature, and need no explanation. We must instead show how these properties fit with and diverge from those identified in physics and chemistry, for which non-teleological concepts suffice, and therefore how they can emerge from prior physical processes that lack these properties.

To accomplish this paradoxically requires that we must follow the strictures on introducing teleological properties as explanatory principles. Thus we need to assume eliminativism in order to demonstrate that it does not provide a complete metaphysics. Assuming this *reductio* stance helps to avoid unwittingly smuggling unexplained teleological principles into the proposed explanation of how teleological properties can emerge. To this end, we have developed a simple thought experiment in which all of the processes involved are known physical-chemical processes and their interrelationships are simple enough to ensure that no unexplained mechanism is invoked.

The central claims proposed in *Incomplete Nature* are derived from an analysis of just such a simple *and empirically testable* thought experiment. Despite the simplicity of the physics and chemistry invoked, and the transparency of the dynamical assumptions involved, we believe that this model system is sufficient to provide an unambiguous *proof of principle* that teleological properties including function, semiosis, self, and value can emerge from components and interactions that, in isolation, exhibit none of these properties.

This model molecular system is called an autogen (also 'autocell' in Deacon 2006) and it is loosely based on the self-assembly processes involved in the formation of viruses, though without the involvement of DNA, RNA, or parasitic dependency. It also superficially resembles theoretical processes described as autopoietic—although it was specifically formulated to address some central insufficiencies of this concept, including the misleading assumption that self-organization is a top-down mode of causality that can account for the higher-order self-preserving unity and intrinsically semiotic nature of living and mental processes.

A simple autogen consists of a reciprocally reinforcing linkage between two different but complementary self-organizing molecular processes. The most basic form of this relationship involves a reciprocally catalytic cycle comprising at least two catalysts that, besides producing one another, also produces a side product molecule that tends to self-assemble into a polyhedral container or tube (as does a virus capsid). Given supportive energetic and substrate conditions, reciprocal catalysis will rapidly deplete the local concentration of substrates, increase the local concentration of reciprocal catalysts, and increase the local concentration of capsid-forming molecules; but unless there is some inhibition of diffusion, the interacting catalysts will diffuse away to the point that catalysis ceases. In parallel, the rate of capsid formation will be most rapid and efficient where the local concentration of capsid-forming molecules is high, and will slow as this concentration drops. The reciprocal catalytic process described above will tend to continuously replenish the local concentration of capsid-forming molecules as the capsid grows, and growth of this containment will diminish diffusion of reciprocal catalysts. With capsid formation occurring most rapidly where reciprocal catalysis is most rapid, the two processes will tend to strongly co-localize. The result will be a high probability that capsids will enclose the very catalysts that produce themselves as well as this containment. Though inert when enclosed, these processes will be reinitiated if the capsid is disrupted (e.g. by the effects of heat) in the presence of catalytic substrates, and thus reconstitute itself (repair damage). Depending on the extent of capsid disruption, the reconstitution process might resume in a more distributed way, thus resulting in the production of two or more replicas (a form of replication). The logic of simple autogenesis is depicted in Figure 4.

There is an interesting analogy between the logic of buzzer function (discussed in the previous section) and autogenesis. Both alternate between two states that, when each is

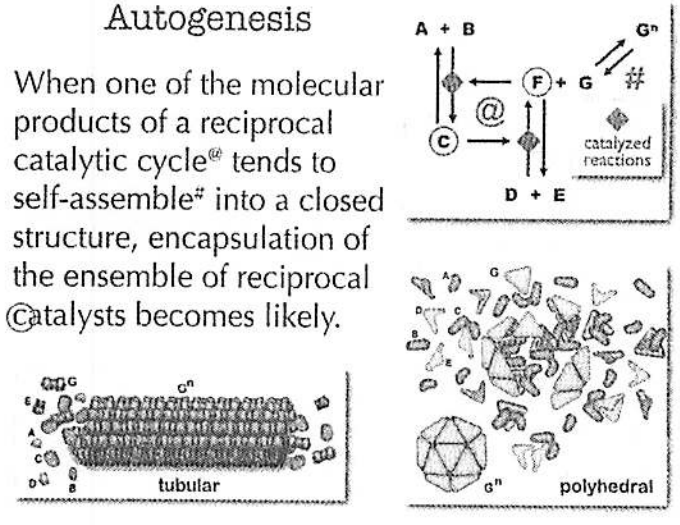

Figure 4. The logic of autogenesis. Lower left: a depiction of a polyhedral autogenic structure. Lower right: a depiction of a tubular autogenic structure. Upper right: an abstract reaction diagram where letters represent distinct molecules, circles indicate catalysts, diamonds indicate catalyzed reactions, @ indicates a collectively autocatalytic cycle, and # indicates the self-assembly of capsid-forming molecules.

achieved, inevitably and necessarily will lead to its own cessation and the initiation of the other. Both systems cycle between a relaxation phase (relaxing the spring and going to temporary equilibrium, respectively) and a work phase (the action of the electromagnet and initiation of autocatalysis and self-assembly, respectively). Both also are set up so that this will continue indefinitely so long as supportive conditions (battery power and energy-rich catalytic substrates, respectively) are present. Of course, there is a fundamental and critical difference: the autogen's dynamical organization serves to prevent the loss of this capacity by working against any disruptive influence. A buzzer's alternating states are merely each other's precipitating conditions, making each other more probable; but they play no part in whether or not this capacity is maintained.

Like the more complex reciprocal constellations of complementary self-organizing processes that constitute simple organisms, the constraint-generating dynamics of each of the component self-organizing processes in autogenesis reciprocally generate each other's supportive boundary conditions. This reciprocal codependent maintenance of critical boundary conditions constitutes a source of autonomy by providing a persisting locus for the specific global constraints required to channel energy in a way that does the work of continually preserving this very capacity. Deacon (2012) has termed this end-directed self-preserving process organization *teleodynamics*, in order to highlight its intrinsically end-directed disposition.

This intrinsic source of persistence is a critical distinguishing feature. The critical boundary conditions for any self-organizing process (such as autocatalysis) are entirely provided by factors extrinsic to that process. For example, all the conditions that contribute to the persistence of a whirlpool in a stream are imposed extrinsic to the whirlpool, whereas some of the most critical conditions that contribute to the persistence of an organisms are intrinsic to that organism. Although living organisms are as dependent on an environmental energy gradient as is a whirlpool, the whirlpool's form is directly dependent on a constant flow of material and energy, whereas our form is only intermittently dependent on an energy gradient. And, moreover, while a whirlpool (like other self-organized systems) is organized in a way that most effectively dissipates the gradient that produces it, an organism uses energy and material gradients to repair any degree of organizational degradation.

So a self-organizing process alone or merely linked with others (as in hypercycle relationships; see for example Eigen and Schuster 1979) cannot be a locus of its own autonomous self-regulation. Only this codependence of reciprocal boundary conditions can provide what amounts to autonomous self-preservation, and a precise dynamical determination of self versus non-self.

This intrinsically maintained self-specification is both self-referential and self-determinative. In semiotic terms, this form of higher-order reciprocal constraint on constraint generation is effectively a form of information that is dynamically interpreted when it channels work to produce a second replica of the original physical system in which it will again become embedded, complete with this same future capacity. This higher-order constraint is thus substrate-transferrable because it can be maintained across complete replacement of the molecules that preserve and generate it. It is information: a form that informs. What makes this form of constraint more than a mere restriction, structure, or regularity is that its most distinctive property is not anything present or intrinsic, but rather something that it potentiates—something that it makes more likely to happen in the future.

We argue that autogenesis exemplifies the simplest form of molecular system that can constitute a living being, whereas processes described as *autopoietic* (see e.g. Maturana and Varela 1980; Thompson 2007) if they only involve self-organized processes that are not reciprocally codependent, cannot provide the autonomous self-reparative, self-reconstituting, self-replicating dynamics necessary to distinguish the system-self from its *Umwelt*. Such a reciprocal form-generating dynamics is the foundation for biosemiotics because signs are ultimately forms that are interpreted via the generation of new forms, which in turn further contribute to the persistence of this interpretive dynamics. The synergy constraint between self-organized processes that is preserved in autogenesis is thus a formal sign, which is interpreted by the process of being preserved by autogenic repair or replication. Lacking this self-referential dynamics, there can be no "other" to be represented and no interpretive "self" for which this other is relevant.

The partial analogy with the buzzer is that both alternate between an energy-driven phase and a relaxation phase such that each potentiates the initiation of the other. In the phase of the autogenic process when its containment is breached and its contents are "spilled" into the environment, it is energetically active and entropy increases as catalysis generates new molecular components and self-assembly rebuilds the molecular container. This is roughly analogous to the energetic phase of buzzer dynamics, which is driven by the flow of current that produces a magnetic field. The pull of the magnet does work on the contact bar, pulling it away from its equilibrium condition where the spring is tensed. In autogenesis, the molecular work continues until closure stops the catalytic process and entropy production ceases. This is roughly analogous to the way that the electromagnet pulling on the contact bar breaks the circuit and shuts itself off, thus stopping work and allowing the spring to spontaneously contract mechanism to "fall" back to a relaxed state, but resetting conditions for the energetic process to recur. Unlike a buzzer, however, autogenesis cycles between spontaneous disruption of its critical structural integrity and active reconstitution of it.

Although most living organisms maintain their critical functioning inside a membrane, a skin, a shell, or exoskeleton, these are only artifactual correlates of what actually separates self from other. Similarly, while in its inert closed state an autogen is unambiguously physically bounded, defining an inside and outside. But its shell is not what individuates it. First, the shell is a critical constituent of the material autogen and so is not merely a separator. Second, the individuation and persistence of autogenic organization is maintained even when this physical boundary is breached and non-contained catalysts and capsid molecules are distributed into the surrounding environment in the process of reconstituting the inert state. Like all organisms, it is both unambiguously individuated and distinct from its surroundings while also exchanging its constituents with substances from that environment. Its individuated continuity is therefore not materially constituted.

This prompts the question: What persists across the transitions of autogen reconstitution and reproduction despite complete replacement of its material constituents?

Absence and constraint

Something clearly is conserved within a long lineage of broken and reconstituted autogens, even if there is no particular material or energy that is preserved along the way. Because that "something" is not only preserved but is critical to the self-similarity of the material autogenic structure that iteratively and persistently repairs itself, it must also definitely

exist. And yet, although it must always be exemplified in some physical structure or local collection of structures, it is clearly not identical to these material-energetic features. What exists and persists is a form, but it persists because of a constraint. But a constraint is something that prevents something else. It may be something external, like a container that prevents movement of liquid from flowing out, or an intrinsically generated limitation, like the way that water flowing around an obstruction will form into a whirlpool where the internal tendency to regularize limits the persistence of more chaotic flow patterns. What persists in the standing whirlpool over time is this intrinsically generated constraint on the pattern of flow, but this persistence is entirely determined extrinsically. If the flow changes significantly, it can vanish. Though intrinsic forces within the local water flow generate the whirlpool regularity, they only exist because of the extrinsic flow. So the whirlpool's existence is an entirely dependent existence.

The situation is more complicated for the autogen. As described above, both the reciprocal catalytic and self-assembling processes involved in autogenesis generate constraints. In this respect, each is analogous to a whirlpool that constrains the pattern of the flow so long as there is continual throughput. They each only continue so long as resources are available. When coupled as in autogenesis, their codependence takes the place of some of this extrinsic constraint. Thus, reciprocal catalysis drives local catalyst and capsid molecule concentrations temporarily beyond equilibrium concentration in a way that keeps pace with the rate that the self-assembly process decreases capsid concentration; and the self-assembly of the impermeable shell restricts diffusion that might otherwise allow the local concentration of catalysts to drift toward equilibrium. These two constraint-generating processes each produce the other's required boundary conditions. But this codependence (or mutual interdependence) is an additional constraint; an additional prevention. It prevents each component process from reaching local equilibrium and stopping. Because of the way each component process is regulated by the other, this reciprocity constraint has the curious property of preserving itself. It is a constraint that indirectly prevents itself and the whole material dynamic process from fading out of existence. Unlike the whirlpool and other merely self-organized processes, the autogenic process is maintained by this *intrinsic* constraint that specifically counteracts any tendency for the organization of the whole to dissipate.

A constraint is reflected in what doesn't occur, in what is absent or prevented. In the case of the autogen, what is prevented is the ubiquitous second-law tendency for the constraints it generates to be fully dissipated. Their reciprocal codependence prevents each of the component constraint-generating processes from being eliminated, and this in turn prevents their reciprocal codependence from being eliminated. In a strange sense, then, preventing certain potential chemical and thermodynamic processes from occurring prevents this prevention from being eliminated too. It is the continued absence of what could have otherwise occurred that this absence perpetuates.

It is this higher order constraint on constraint-generating processes that forms the core feature we identify with the self/other distinction that defines an organism. "Self" in this sense is that which has a disposition to resist going out of existence. In the context of the ubiquitous second law of thermodynamics, all constraints tend to get dissipated in time. So like Alice (*Through the Looking-Glass*) running with the Red Queen just to stay in one place, a constrained far-from-equilibrium system can only persist by constantly working in the opposite direction to the second law. In the world as understood by

Plato and Aristotle, form could exist irrespective of work to produce and maintain it. But form is a reflection of constraint; and in the world as we now know it, in which entropy increase incessantly breaks down constraints, the persistence of form cannot be assumed.

In previous works, it has been tempting to emphasize the ontological importance of absence relations by using the somewhat misleading phrase "the efficacy of absence." This rhetorical trope unfortunately undermines the point that it intends to emphasize. So a bit of conceptual repair is necessary before proceeding further.

In the brief discussion of the *Tao Te Ching*, mentioned above, verse 11 was described as a sort of synopsis of the essence of the logic underlying *Incomplete Nature*. The opening line of the verse cites the hole at the hub of a wheel. The hole is an example of what Deacon calls a "constitutive absence," and was used as a metaphor for the property that characterizes a word's meaning, a shovel's function, or an organism's purposes; that is, the property of existing in relation to something not immediately present.

In the case of the hole at the wheel's hub, the absence of material at this position is a necessary feature of what constitutes the wheel. Without reference to the material of the wheel it is not a hole at all, just a region of space. The wheel must have this absence of material at its hub in order to be able to rotate with respect to a rigid axle. Only an absence of material between that of the axle and that of the wheel will allow this to occur. Of course, the material components of the wheel are in no way dispensable to the use. Without them, there is no wheel. But neither can one dispense with the place at the center where there is no material, otherwise the whole wheel is useless. This intrinsic functional relationality is made explicit in the final line of the Taoist verse from which this concept is drawn. It says (in Deacon's interpretation): "Though we can only work with what is there, use comes from what is not there." It is "use" that we are focused on here, not merely the stuff or its absence.

This is linked to another potential misunderstanding of the concept of absence. Mistakenly treating absence as non-being might lead one to ask: How can the absence of something be physically extended in space and time? Again, consider the wheel. The wood of the rim, spokes, and hub is extended in space and time and the hole has a precise locus and extent in relation to them. Wherever the hub is, there in the center is the empty space. Thus, its extension— its spatio-temporal existence; that is, its size in a particular location—is unambiguously and quite precisely determined by this relational existence. Though the hole is defined negatively, it nonetheless can be said to "exist" in this relational sense.

The hole is an *actuality*, not a mere possibility. In this respect, it cannot be accurately characterized in modal terms. It is not merely the possibility of material being located there. The movement of the cart utterly depends on the hole actually being there. Without the absence of material at this location, rotation of the wheel would not be possible. So, just as the roundness of the wheel's material structure is critical for the rolling of the wheel, the hole at its center is equally critical for the functional, non-sticking connection between the cart's axle and the wheel.

The "efficacy" confusion is also related to this misidentification of absence with non-being. Defining the concept of *constraint* in terms of absent degrees of freedom makes it tempting to think of absences *doing* things. But absences themselves don't do work, nor do they resist work. And yet there is no work without absence. The absent degrees of freedom are only part of the story, necessary but not sufficient. Physical work requires

the release of energy in a *constrained* context. Thus the exploding gasses in an engine cylinder are constrained to expand only in one direction and thereby move a piston in the one degree of freedom that is least resistant to the force of the explosion. These constraints can thereby enable a process of entropy increase to drive another process toward a lower entropy state (such as moving a car uphill). Constraints don't *do* work, they enable and channel the outcome of energy release. This has led several writers (e.g. Juarrero 1999; Emmeche, Køppe, and Stjernfelt 2000) also to reinterpret Aristotle's notion of formal cause in terms of constraint (though these authors additionally confuse it with "downward causality"). The point is that physical work requires both a formal (constraint) and an energetic (efficacious) aspect. Without either, no work can be done and change merely proceeds in what Deacon (2012) calls an orthograde direction.

Constraints are intrinsically relational phenomena. They are reflected in relationships between degrees of freedom that are excluded and those that are not excluded. And these are always degrees of freedom of some physical process of change. So when we argue that the constraints that characterize autogenesis actively preserve themselves, we are not mentioning the fact that this active preservation necessarily involves physical processes that by virtue of these constraints do the work of preventing these same constraints from degrading. And because these constraints are preserved, whenever thermodynamic conditions enable the resumption of chemical work, this renewed energetic gradient is again channeled into autogenic catalysis and linked self-assembly processes. The chemical reactions that are thereby prevented are those that would degrade this capacity to prevent potentially degrading reactions.

Section III

To be and not to be

It is our contention that this analysis may finally provide a partial answer to Descartes' dilemma: How can an extensionless (non-material) mode of being affect the causality of extended (material) beings?

The great success of molecular biology over the past half-century has been achieved by a methodology that is effectively a marriage of chemistry and engineering logic, and a strict prohibition on the use of teleological concepts for explanatory purposes. Yet, although physics and chemistry have no place for teleological concepts, the same cannot be said about engineering. The devices that engineers produce *are* designed. They are constructed to perform particular functions—to achieve human aims. A machine doesn't benefit from its functioning; people do.

Assuming this end as a critical constraint, the process of designing, building, and operating machines can be achieved using just the tools provided by physics and chemistry. But the machine's usefulness is more than the physical and chemical processes that it utilizes. It is not some physical property of the machine. It is a constraint imposed from outside.

Of course, the same is not true for organisms, even though they are also physical and chemical phenomena. Nevertheless, it is entirely appropriate to describe their various component processes as mechanisms or even "molecular machines" (a term often used to describe protein complexes such as ribosomes). In organisms, however, the locus of the constraints that determine their functions is not extrinsically imposed. Because

every part of a cell, for example, is produced by and helps to produce each of its other parts, reciprocally, each of its "molecular machines" also contributes to the "design" constraint that produced it. Although, it seems convenient to think of the DNA in a cell as being the source of these constraints, as though these are the blueprints created by some extrinsic influence like natural selection, that would be too simple. DNA itself is replicated by this cellular machinery, as are all of the cell's other components. So DNA is also just part of this synthetic reciprocity. Moreover, it is because organisms are incessantly working to preserve their critical functional constraints (in themselves and via reproduction) that there is anything susceptible to natural selection. These constraints are not a consequence of natural selection. They are its precondition.

So we feel confident that when we say an organism functions to protect it*self*, we are using 'self' in a non-metaphoric sense to mean something intrinsic and autonomous. And it is why we attribute some degree of autonomous agency to selves, whether the selves of micro-organisms or of animals with brains and complex behaviors. Though we recognize that there is a difference in the kinds of selves that are exhibited at these vastly different levels of living forms, we also recognize that all differ in these respects from clouds, clocks, or computers.

And yet, as the comparison between engineered constraints on machine design and evolved constraints on organism "design" indicates, the nature of this self that benefits is not exactly identical to the physics and chemistry that exemplifies it. We are not at all uncomfortable with the source of functional constraint being no part of the physical-chemical constitution of an engineered device. By analogy, it has been easy to envision that the design constraints of organisms are also no part of their physical-chemical makeup; locating them in a divine mind, an immaterial vital substance, or in a process called natural selection.

But this is where things get counterintuitive. In a living organism, the locus of the functional constraint is not outside. It is an intrinsic feature. Yet, as in engineered machines, this constraint is not identical to the organism's (or autogen's) physical-chemical constitution. It is the ontological status of this intrinsically generated and preserved—but non-material—constraint that needs to be explained. Because it isn't any part of the substance of an organism or autogen, it is immaterial and without clear extension. Nevertheless, it unequivocally exists and determines the unambiguous distinction between dead and alive, inanimate and animate, insentient and sentient, matter and mind. Both life and autogenesis exhibit a mode of being that can be described as a capacity to organize work so that it counters factors that tend to degrade this capacity to organize work so that it counters factors that tend to degrade this capacity to organize work ... and so on. This recursive self-directed work determines a mode of being that perdures because of the way it incessantly projects itself into the future.

Like Descartes' *res cogitans*, this mode of being is something formal and immaterial and yet it nevertheless affects the materially extended being of an organism or autogen. In this way it provides a new way to interpret the Cartesian discontinuity between the domain of physically extended material-energetic causality (*res extensa*) and the domain of experiences, meanings, and values that appear to lack material extension and simple location (*res cogitans*). It is an approach that is neither dualistic nor monistic in the usual senses of these concepts, but *emergent*. The domain of *res cogitans* emerges *de novo* from phenomena that are unambiguously classified as in the domain of *res extensa*. But the resulting

complementarity between extended material-energetic features and non-extended "absent" features makes the *res cogitans* neither reducible to *res extensa* nor independent of it.

Emptiness and the Tao

We can consult, also, the ancient thinkers on the question of metaphysics and absence. As one might expect, it is in the traditions of the outliers that the being of emptiness and absence are found to be integral to metaphysics. But there is a very great difference between "emptiness" as understood in Mahayana Buddhism and "the yielding, the absent" of the Taoist understanding of *yin*.

In Buddhism, *śūnyatā* is the fact of the *emptiness* of "own-being." Buddhism acknowledges that we have an idea of what it would be to have "own-being," but we never run across such a being in the world. The more deeply we inquire into the being of the world that we encounter, the more we see that nothing exists in a way that is free from dependence on other things. Our idea of "own-being" does not come from, does not derive from, the world we know. It is an idea that arises in the human mind, but is never found in the real world. This is the meaning of "emptiness" in the Buddhist tradition.

Plato also concluded that nothing that has its own being is to be found in the world of impermanent phenomena that we encounter. This conclusion led him to reason that there had to be a separate non-physical realm that contains eternal forms. Only that immaterial world and the immutable forms within it were "the really real," *ho ontos on*.

His student Aristotle eventually denied that Plato's separate realm of eternal forms exists, and instead taught that a set of eternal forms very much like Plato's does exist, but *in* the world we experience, embodied in the specific forms of each species of plant, animal, and mineral. A species-specific immutable form inheres in each individual living being, compounded with and individuated by what he called prime matter: *hyle*, matter with no substantial form of its own. So, for Aristotle, every animal and plant has "own-being," an internalized eternal form that was not created and will always continue to be individuated in concrete individuals by the reproduction of offspring.

This is precisely the concept of being that the Buddhist insight denies. The Buddhist understanding of *emptiness* denies the possibility of such autonomous being as Parmenides, Plato, and Aristotle believed to be necessary. Accordingly, the actual beings of the world, including ourselves, are neither eternal nor immutable. Everything is ultimately impermanent and changeable.

Natural scientists of our day, like Buddhists, no longer believe in Aristotle's eternal essences in things. The natural sciences put this issue to bed long ago. But this rejection has left the concept of being ungrounded.

In contrast, the use of the terms "absence" and "constitutive absence" in *Incomplete Nature* frame a different issue. It is the absence of something that was once there, or that has a significant possibility of occurring, or that is the result of a constraint on a tendency that is of interest. This concept of *absence* is more like the Taoist "spirit of the valley." Two mountains are each *yang*, but the valley between them is *yin*. The mountain and the valley come into being at the same time by the same process.

In a world where impermanence is the rule, all form must be the result of constraint. Constraint is responsible for what is not there, what has been prevented from occurring. What is present, then, is what was not prevented.

The Parmenidean lineage of metaphysics concentrated on what is *yang* and denigrated the *yin*. Western civilization, following in these footsteps, concentrates on what is *yang*—what is there, what is strong, what is unyielding, what is positive. So, in contrast, what is emphasized in *Incomplete Nature* is the *yin*—that mode of absence that necessarily complements what is present. That being is both due to what happens *and* what is prevented from happening is the core metaphysical assumption at the foundation of *Incomplete Nature*.

A metaphysics of incompleteness?

The autogen thought experiment has helped us to understand how the existence of an individuated self can be a function of a process that doesn't allow itself to be completed. Each material-energetic state of the autogen tends to potentiate the appearance of its alternative precisely because of its constant susceptibility to dissipation and dissolution. In this respect, its persistence is paradoxically determined by the very self-undermining tendency implicit in its far-from-equilibrium mode of existence.

Its codependent form of unity is then a mode of existing *in futuro* by virtue of this essential incompleteness. In other words, it requires that our conception of being must necessarily involve perdurance and thus both an intrinsic relation to its own non-being in order to resist this potential loss of being. In the case of living and mental modes of being, then, to exist is to incessantly counter the ubiquitous tendency for constraints to dissipate with the increase of entropy. This mode of intrinsically incomplete being—being with respect to what is not—is not only the core attribute of self; it is the very essence of all teleological relationships, including functions, purposes, meanings, and intentions (in both senses).

So where does this metaphysical claim reside with respect to the history of Western metaphysical paradigms? In many respects, as we've seen, it cannot easily be assimilated into any of the traditional divisions. A very superficial classification of the commonly recognized major metaphysical paradigms discussed in modern Western philosophy roughly includes Cartesian dualism, physicalism, idealism, and neutral monism. All are to some extent based on claims about ultimate substance; that which exists independent of anything else. Thus, dualism claims that there are two fundamental kinds of substantial being: physical (extended) and mental (non-extended). Physicalism treats physical being as primary and mental being as derived, dependent, or epiphenomenal. Idealism treats mental being as primary and physical being as derived, dependent, or epiphenomenal. And neutral monism argues that both physical and mental modes of being are derivative from and dependent on a more fundamental mode of being that has attributes of each (also described above as dual aspect).

The metaphysical claim we are proposing here could be seen to borrow features from all four of these and yet, because of the insistence that extended absences are inescapably part of the existence of life and mind, the underlying physical/mental dichotomy that each of these views relies on is dissolved. It is not a simple version of physicalism because the teleodynamic constraints that define the "information" we associate with living and mental processes is not identical with or reducible to the material-energetic correlates of these living and mental phenomena. And yet it has definite existence, spatial-temporal location and extension with respect to this material, as well as influence with respect to its own persistence and the persistence of certain general configurations of matter and energy. It is

also not a simple version of neutral monism, because it assumes that material-energetic phenomena can exist without association with mentalistic (teleodynamic-semiotic) phenomena, but not the reverse. This is despite the possibility that these latter phenomena are not reducible to these material-energetic correlates. Teleodynamic properties are in a sense the complement to material-energetic properties they emerge from. It is neither something from nothing nor something new from something prior.

The point is simple: presence and absence must be mutually interdefined. Present substances are individuated by absences, even in an early stage of the universe prior to the existence of any teleodynamic phenomena. The claim we are making is that *mental phenomena only appear to be mutually exclusive from physical phenomena because we fail to recognize that absences actually do exist.* They are not non-existent, neither are they non-physical; they are just non-material and non-energetic.

The autogenic dynamic by which living selves emerge into existence has a mode of being that quite precisely parallels the Buddhist notion of interdependent co-origination. Life and mind arise *de novo* via the interdependence of processes that independently develop toward their own elimination, but when coupled prevent each other from succumbing to this otherwise inevitable end. From the mutually supportive interdependence of these constraint-generating processes, a higher order self-preserving form of constraint emerges. Rendering the Buddhist concept of "no-self" in teleodynamic terms, we might rephrase it to mean that self is not some thing, but a mode of absence.

Recognizing the emergence of novel modes of absential relationships like living sentience and mental experience—that now exist but didn't long ago —also requires a reconceptualizing of some even more fundamental metaphysical assumptions. These are assumptions concerning the coherence and completeness of the cosmos, and a reconsideration of even the very notion of time.

To pursue these implications will take us far beyond even the radical claims we have already made. The following comments are therefore not just highly speculative but little more than blue-sky brainstorming. Nevertheless, we offer them because of their possible relevance to a broader theological discussion.

First, consider the wider implications of treating absence as a mode of being, and particularly of the way that absences can beget new modes of absence, as in the origin of life and the origin of mental experience. One of the most compelling implications of Gödel's proof is that even for a formal system capable of exemplifying an indefinite range of internally consistent relations (as in the case of mathematics), it is not possible to completely specify all the possible relations that it must contain—even abstractly. This is because of the unavoidable capacity to produce self-denying "liars' paradox"–like expressions that are undecidable because their analysis can't be completed. As we have shown, teleodynamic systems are organized so as to prevent their own probable cessation of existence, and therefore with respect to states that are presently absent. This is the ultimate origin of representation: present being that is oriented with respect to some absent being. This property of representation is a defining attribute of any formal system. It is the loophole that allows the liar's paradox and ultimately leads to Gödel's discovery. So, in this respect, this possibility enters the world with teleodynamics. And with it, an unspecifiable openness and incompleteness, not merely because of infinite time, but as a fundamental property of being.

It is in the spirit of this radical ontological openness that we have explored some implications of a metaphysics based on ultimate incompleteness. Perhaps the most significant

consequence of this vision of existence is what it *doesn't* determine, even in some ultimate sense. Like Gödel's coherent and consistent but fundamentally incomplete formal system, the very nature of existence may not be resolvable into a simple being/non-being distinction. The possibility that uncomposed, complete, independent being might be intrinsically self-contradictory opens the door to a metaphysics that is not merely incomplete, but by this very fact is the very essence of creativity. And creativity, as well as emergence, are intrinsically temporal concepts. Time is, of course, the mystery of mysteries. The concepts of change and absence are intrinsically temporal concepts; and, as we have seen, one way to resolve the many twists on the liar's paradox that we have described is to introduce time and alternation. But what if we consider this logic in reverse? What if the necessity of this paradoxical nature of things is what requires the very nature of existence to be temporal and intrinsically incomplete?

About time

So to complete this journey into a realm where even angels should fear to tread, let's explore this last great mystery from an even more speculative perspective.

Consider another variant of incompletability: the concept of imaginary number. The classic formulation involves trying to determine the square root of a negative number. The relationship of this to the liar's paradox and the buzzer can be illustrated by stepping through stages of solving the equation $i \times i = -1$. Dividing both sides by i produces $i = -1/i$, and then substituting the value of i one gets $i = -1/-1/i$ and then again $i = -1/-1/-1/i$ and so forth, indefinitely. With each substitution the value alternates from negative to positive and cannot be resolved (like the true/false of the liar's paradox and the on/off of the buzzer). But if we ignore this irresolvability and just explore the properties of this representation of an irresolvable value, as have mathematicians for centuries, it can be shown that i can be treated as a form of unity and subject to all the same mathematical principles; as can 1 and all the real numbers derived from it. So $i + i = 2i$ and $i - 2i = -i$ and so on. Interestingly, $0 \times i = 0 \times 1 = 0$, so we can conceive of the real number line and the imaginary number line as two dimensions intersecting at 0, the origin. Ignoring the many uses of such a relationship (such as the use of complex numbers with a real and imaginary component), we can see that this also has an open-ended consequence. This is because the very same logic can be used with respect to the imaginary number line. We can thus assign $j \times j = -i$ to generate a third dimension that is orthogonal to the first two and also intersecting at the origin. Indeed, this can be done again and again, without completion; increasing dimensionality without end (though by convention we can at any point restrict this operation in order to use multiple levels of imaginaries for a particular application, there is no intrinsic principle on which to base such a restriction).

So what could this abstract exercise have to do with time? First, consider the meaning of negative values. They can represent subtracted quantities, absences, or something constrained. So, the various versions of the liar's paradox we have discussed can be understood as an absence times an absence times an absence, and so on—a self-undermining relation that alternates in value but never resolves. The three spatial dimensions allow us to discern differences—that is, where things are present and absent. As we have seen, there are things that are present with respect to an absence and absent with respect to a presence. If the imaginary number analogy is relevant here, then we must admit the possibility of an indefinite dimensionality to the nature of existence and the necessity of irresolvable change.

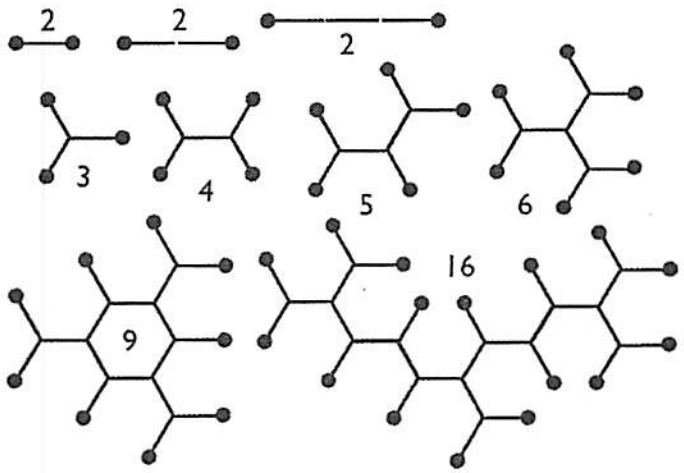

Figure 5. An illustration of the way that combinations of triadic relations can constitute n-adic relations of diverse structure (though this cannot also account for relationships that are self-undermining).

Charles Peirce became fascinated with triadic relations in part because he noticed that they could be combined to produce four-part, five-part, and *n*-part relationships (see Figure 5). So three dimensions, 1 and *i* and *j*, are sufficient to deal with fixed relationships of arbitrary complexity. But then there is change to account for.

In the Einsteinian universe, time is a single spatialized dimension in which there are differences of relative position and in which movement is in some sense illusory. Indeed, the Einsteinian universe is often depicted as a four-dimensional "block" universe. In such a universe the future and the past are fixed; and even if we insinuate quantum indeterminacy into this picture, there isn't any "real" chance, because all past and future configurations are fixed (even in a multiverse). But what if time is itself a consequence of incompletable dimensionality; not a single spatialized dimension, but a feature of the open-ended nature of present/absent relationships compounded on each other?

Though the abstractness and hand-waviness of these last few speculations cannot be rigorously defended, they are relevant to consider in the light of another deeply held intuition: the sense that "strong" emergence is an inevitable feature of the universe and true creative freedom is fundamental. In this respect, the term "imaginary dimension" (Figure 6) may be at the same time both misleading and prescient.

Ultimate apophasis

From a theological perspective, this exploration may also have interesting implications. To the extent that one imagines God to include teleological properties or to embody something like knowledge, the inescapability of this paradoxical undecidability may be worth considering. This is particularly relevant in light of the Thomistic argument that the only limitation relevant to God is the necessity of non-contradiction. Non-contradiction is required for consistency, and the avoidance of equivocation; but, as Gödel discovered, to preserve consistency we must accept fundamental incompleteness. So it is relevant to ask to what extent these constraints might apply even to the essential nature of God, or perhaps to the inconceivability of God.

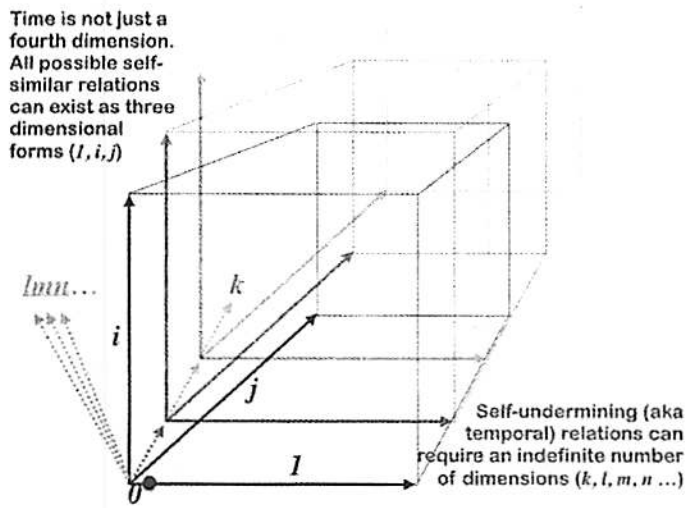

Figure 6. Indefinite dimensionality of space-time based on the incompletability of imaginary dimensionality.

Pseudo-Dionysius the Areopagite (writing before 534 CE), influenced many theologians in the West with his negative theology. He claimed that we cannot conceive of God, cannot articulate in words what God is, no matter how hard we try because there is no adequate correspondence between a finite mind and language and an Infinite Mind, a finite being and an Infinite Being. So, whatever we imagine, or intellectually reason God to be, or even to be like, we must deny that He is like that. When we think of God's compassion, we must deny that it is anything like the compassion that humans can have for one another. When we think of God the Creator, we must not think of any type of creation that we know of. God's creation cannot be like what a carpenter or sculptor would do. Nor can His creation be anything like the Big Bang.

A medieval statement of this approach was *nec taliter, nec qualiter, sed totaliter aliter* ("not of this kind, nor of this quality, but totally different"). From this perspective, it makes little sense to talk of God's purposes, or influence with respect to worldly processes, or even ultimate conceptions of being. Indeed, there is not only a profound reverence and humility expressed in such a theology, but also a deep reasonableness in it, which may be relevant to metaphysical speculation as well. A metaphysics of ultimate incompleteness—a Gödellian metaphysics, if you will—can neither be based on a complete and perfect foundation nor can it allow contradictories: the ultimate apophasis. But, as the *Tao Te Ching* tells us, "The nameless is the beginning of the ten thousand things."

Conclusions

Incompleteness and the spiritual life

The spiritual life has been called, for many centuries, in both West and East, the Path of Perfection. The word "perfection" has in its etymology and in its core significance, the meaning: "finished." That which is perfect is not merely *done*, it is *done all the way through*—that is, completely.

The spiritual path in the West has been in a way bedeviled by this concept, which finds its root in the extreme difficulty that Greek thinkers had with the changeability of the world. Motion, change, was not really intelligible. Now, it is true that motion and change are not really intelligible. So the early Greek thinkers were right about that. But they were convinced in a deep way that for something to be real, it had to be intelligible. So, they came to the conclusion that only that which is exactly what it is can be real, can have being.

Aristotle, trained both in close observation of the biological world and in the Platonic tradition of pure, unchangeable forms, took it upon himself to solve the mystery of motion. A large portion of his theoretical structure is an effort to bring some intellectual clarity to *kinesis*, motion and change. In the *Physics* (Book VIII, Chapter 5, 257b6), he concludes, "Moreover, we have established the fact that it is the moveable that is moved; and this is potentially, not actually, in motion, but the potential is in process to actuality, and motion is an incomplete actuality of the moveable."

What we are working to do, in parallel with Aristotle, is to understand the metaphysics of incompleteness. We are claiming that there is something *essentially* incomplete about this universe. Aristotle, in bringing motion into his metaphysics, was attempting what we see as a first step in an accurate assessment of the universe that we encounter and that gave us birth.

Once we open ourselves up to the possibility that it is a mistake to imagine that to be real has to mean to be permanent, eternal, pure, completely present, then we can take another look at what must be a metaphysics of the impermanent, the temporary, the absent, the changing. We can see in the spiritual life a kind fetishism of perfection—of the completion that is the truly good, the flawless, the blameless, the single right response to any moral case before us.

We propose that, just as the truth of this incomplete universe is not what it *is*, but what is emerging, so the root *being* of the universe is not ontological permanence but emerging creativity, the coming to be of what was not.

In spiritual practice this understanding frees us from the judgment of perfection, of the good as completion. The art form that is the relevant analogy to the spiritual life is dance, not sculpture. Motion, as Aristotle clarified, is essentially *incomplete*. The spiritual life is the doing, the practice, the going—not the arriving. The authenticity of the spiritual path is in the walking of the path.

The paradox of the spiritual life, then, is that that which is *perfectus* (complete) is forever incomplete. It is only in incompleteness that the real, the good, the true, the one and the beautiful come into being.

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