

## THE OMEGA POINT THEORY: A MODEL OF AN EVOLVING GOD

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### 1. *Introduction*

Science is now considered by many to have refuted the fundamental tenets of the Christian religion. Many twentieth century theologians (and many scientists) have attempted to avoid conflict between science and religion by claiming that science and religion deal with wholly different forms of knowledge: the realm of science is the natural world, while the realm of religion is human morality and religious experience. But this division must ultimately fail. The starting point of morality is an understanding of humankind's place in nature, something that is obviously a scientific question. Our scientific understanding of our relation to the natural world must necessarily affect religion. Many important Roman Catholic authorities have recognized this by actually taking a stand on cosmological questions. They have claimed that Catholic doctrine requires the physical universe to have begun a finite time ago.<sup>1</sup> Furthermore, it is obvious that religious experience is truly meaningful only if there *really is* a God out there who is the source of this experience; no Christian believes for a moment that the experience of the presence of God is merely the subject matter for a specialist in abnormal psychology. Throughout the whole of human history, religion has been inextricably entwined with the science of the day, and this will never change.

In this paper I shall discuss two recent developments in physics which have important implications for religion. The first is the realization that we humans are present in the Universe at an exceedingly early time in its history. Almost all of universal history, and possibly almost all of the history of life, lies in our future. If most of life is in the future, then it is exceedingly unlikely that *Homo sapiens* is the most advanced form of life that will ever evolve in the cosmos; rather, our species should expect to be replaced one day by another. Traditional religion must come to grips with the fleeting existence of our species in universal history. It is our relative insignificance in time, not space, which is the real challenge posed by modern cosmology for traditional religion.

I shall show that this view leads naturally to a physical theory for an evolving God, which I term the Omega Point Theory. I shall outline this theory in Section 3.

The second development is the possibility of a Theory of Everything (TOE). A TOE might imply that there is only one logically possible

universe. This would refute both the Cosmological Argument and, more importantly, its premise that God had some freedom of choice in creating the universe. The traditional God would be made superfluous, but an evolving God might be made necessary. The possibility of a TOE and its implications for religion will be discussed in Section 4.

## 2. *The Idea of an Evolving God*

It is the purpose of this paper to provide an argument for the existence of a Supreme Being who is also a Person. My analysis will be carried out entirely within physics itself, and although I shall feel free to use terminology from religion — omnipotence, transcendence and immanence, omniscience, and omnipresence, for example — I shall regard these notions as physical concepts, and accordingly define them in physics. However, the God whose existence I shall claim arises naturally in modern cosmology is not the traditional unchanging Deity, nor the wholly other Being of modern 20th century theology, but rather an evolving God somewhat like the God of Schelling, Alexander, Whitehead, and Teilhard de Chardin. An evolving God is very much in the world, creates it, and is created by it. The created and the creator are the same entity seen from different temporal perspectives, and described in different modes. How this works will be made clear in Section 3, where I shall outline the Omega Point Theory. A fuller development of this theory can be found in chapter 10 of *The Anthropic Cosmological Principle*<sup>2</sup> (hereafter referred to as ACP), which I co-authored with John D. Barrow. The theological implications of the Omega Point Theory were strongly de-emphasized in the book, however. There, the theory was presented as a purely physical theory — as in fact it is. But in this paper I shall adopt a theological point of view and present the Omega Point Theory as a model of an evolving God. Here I use the word “model” as physicists use it: a simplified picture expressed in mathematical symbols whose essential features are believed to correspond to reality. The “standard model” and the “Friedmann model” are two examples of this use of the word in cosmology. I am sure that my model of an evolving God is incorrect in its details, but I am also sure that *any* fully consistent concept of an evolving God who is a Person must resemble my model in its essential features. Indeed, I will go further: after I define “person”, “soul”, and “mind” in Section 3 in terms of modern computer theory, it will be clear that it is in the basic nature of “persons” to evolve — to change in time — so that the adjective “evolving” in “evolving God” is redundant.

My model of an evolving God is, of course, dissimilar in many respects to the traditional concept of the Supreme Personal Being. Since my model assumes that at the most basic ontological level there is nothing but physics and the “stuff” studied by physics, my model can conversely be regarded as a challenge from physics to the traditional idea of Deity; it is a claim that not only does the traditional God not exist, He is superfluous.

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feel there is much to be said for some version of the cosmological/ontological argument: there is some entity — a Supreme Being — which *necessarily* exists in the sense that Its nonexistence would be a logical contradiction. The existence of such a Being is believed to be the answer to the questions of “Why is there something rather than nothing?” and “Why *this* universe rather than some other universe?” I shall consider what modern physics has to say about these two questions — and the cosmological argument — in Section 4. The reader is referred to Sections 2.9, 4.7, and 6.14 of ACP for more details. In essence, the answers which many physicists are giving to these two questions are: (1) that the physical universe in its own right necessarily exists, and further, (2) there is only one logically possible universe, for only one solution exists to the equations of physics and there is only one consistent set of equations. Here is what I regard as the greatest challenge to traditional theism: the possibility that the physical universe might necessarily exist in its own right. If true, this would mean that God is at best superfluous unless He is in the world. However, this possibility would not be a challenge but instead a nice completion to my model of an evolving God, in which the Deity and the entire physical universe are two aspects of the same thing, just as a certain collection of atoms acting under blind physical laws from one point of view is also a human being from another point of view. Both modes of description of a human being are equally valid, but epistemologically, neither can be completely reduced to the other, although ontologically a human being *is* at the most basic level a collection of atoms and nothing else. That is, I believe in ontological reductionism but epistemological anti-reductionism in the sense defined by Ayala.<sup>3</sup> I shall assume the truth of this position in what follows. (See ACP, Section 3.2, for a defense of this position). My model of an evolving God is most decidedly *not* a variant of pantheism. God and the physical universe are *not* two words for exactly the same thing.

The postulate from which I shall deduce in Section 3 an evolving God is fundamentally a moral one: value is something connected with life, and thus, if value is to remain in the universe, life must persist indefinitely; the laws of physics must permit forever the continued existence of life. Thus my argument for an evolving God has a certain family resemblance to Kant’s moral argument. Furthermore, this continued existence of any sort of life will imply, as I shall argue in Section 5, not merely a continued existence of a low form of life, but also progressive evolution without limit in spacetime: the limit of both cosmological and biological evolution is a point beyond space and time, the Omega Point. We thus recover a progressive evolution in the large, something which has been forever banished from evolutionary biology. Teleology, although removed from terrestrial biology, reappears when biology is combined with cosmology. I shall develop these ideas, putting the Omega Point Theory in its historical perspective, in Section 5.

### 3. The Omega Point Theory

The crucial fact upon which the Omega Point Theory is based is that we are observing the universe at a very early time in its history. The

universe is 10 to 20 billion years old, and our Earth is 4.5 billion years old. But as large as these numbers are relative to human lifetimes, they are insignificant in comparison to the length of time the universe will continue to exist: even if the universe is closed, bounds on the rate of expansion and the matter density imply at least 100 billion years until the final singularity, and if the universe is open or flat, then it will continue to exist forever. Now life has existed on our planet for at least 3.5 billion years — microfossils of what appear to be quite advanced forms of bacteria have been found which are that old, so life itself must be even older. Probably life of some form can continue to exist on the Earth for as long as the Sun remains on the main sequence, some 5 billion years. Thus we would expect life to continue to exist for longer than it already has existed. This lower bound on life expectancy is much longer than the mere 100,000 years modern man (*Homo sapiens*) has existed.<sup>4</sup> It is also much longer than a typical mammalian species survives, which is about a million years. So if our species survives as long as does the average mammalian species, it can expect to continue to exist for only one five-thousandth of the future of life on this planet. Furthermore, the future history of life on this planet is itself only a tiny fraction of the future history of the universe. These numbers put the human race in its proper perspective in the history of the cosmos.

It is important to emphasize that the above lower bounds on the length of time the universe will continue to exist are *very* solid. That the universe will continue to exist for at least 5 billion more years must be regarded at least as certain as the fact that it has already existed for at least 5 billion years. There is simply no way our knowledge of physics could be so wrong as to falsify this prediction of longevity. Thus, any religious appraisal of the nature and destiny of humankind must take into account this longevity. Almost all Christian theologians adopt a much shorter temporal perspective. This is as great an error — and as great a misunderstanding of humankind's place in nature — as believing that the universe was created a few thousand years ago.

Let us consider the implications of this longevity by assuming that life will continue to exist as long as the physical universe does. Note that this is basically a moral postulate. More precisely, the existence of life is the prior requirement for there to be any morality at all: lifeless and dead matter is neither good nor bad. Furthermore, a universe in which life and intelligence evolved, but in which life (and hence intelligence) and all its works disappeared forever would in my judgement be ultimately meaningless. One can of course adopt other definitions of "ultimate meaning" (see Section 3.7 of ACP for example; traditional Christian theism is one example), but I think we can agree that *if* ultimate meaning is to reside somehow in the physical universe itself, then a necessary condition is for life of some sort to continue to exist. Thus, indefinite survival is a necessary condition for a naturalistic ethics to be possible. If life must die out, then a naturalistic competitor to Christian ethics is not possible. Furthermore, whatever one's views as to the source of ultimate meaning, it is extremely important to investigate whether it is physically possible for life to exist as

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In order to investigate whether life can continue to exist forever, I shall need to define "life" in physics language. I claim that life is a form of information processing (the converse is not true), and that the human mind — and the human soul — is a very complex computer program. This is *not* to say that life is *nothing* but information processing. This naive reductionist view I would strongly reject. All I am claiming is that at the most basic level of physics, life is simply information processing. But there are higher levels of epistemological description. Human beings love others, they have emotional needs and deep feelings. These very real aspects of human life cannot be reduced to simple theorems of information theory and physics. (In principle, these aspects are equivalent to extremely complex theorems, but such theorems would be humanly incomprehensible and effectively undiscoverable. This is ontological reductionism combined with epistemological irreductionism.) The crucial point is that the higher levels must be consistent with the physics level; any discussion of human feelings must be consistent with the general limitations on human minds deduced from physical information theory which is applied assuming minds are computer programs. This is in the end no different from the requirement that a moral philosophy or a work in literary criticism must not contradict the brute physical fact of people having to eat in order to live. I find it fascinating — and one of the most important ideas I hope to convey in this paper — that far-reaching and unexpected conclusions about human destiny can be drawn from the physics level alone.

A complete justification for my claim that the mind is a computer program would fill a book. A central argument is the Turing Test. I thus refer the reader to several books on the Turing Test.<sup>5</sup> See also Sections 3.2, 3.5, 7.2, and 10.6 of ACP. Instead of reviewing the Turing Test, let me give here a religious justification for this claim: I shall justify the computer/information processing model of life and mind simply by pointing out the astonishing similarities between the mind-as-computer-program idea and the traditional Christian concept of the "soul". Both are fundamentally "immaterial": a program is a sequence of integers, and an integer — 2, say — exists "abstractly" as the class of all couples. The symbol "2" written here is a *representation* of the number 2, and not the number 2 itself. In fact, Aquinas and Aristotle defined the *soul* to be "the form of activity of the body." In Aristotelian language, the *formal* cause of an action is the abstract cause, as opposed to the material and efficient causes. For a computer, the program is the formal cause, while the material cause is the properties of the matter of which the computer is made; and the efficient cause is the opening and closing of electric circuits. For Aquinas, a human soul needed a body to think and feel, just as a computer program needs a physical computer to run.

Aquinas thought the soul had two faculties: the agent intellect (*intellectus agens*) and the receptive intellect (*intellectus possibilis*), the latter being the ability to acquire concepts, and the former being the ability to retain and use the acquired concepts. Similar distinctions are made in

computer theory: general rules concerning the processing of information coded in the central processor are analogous to the agent intellect; the programs coded in RAM or on tape are the analogues of the receptive intellect. (In a Turing machine, the analogues are the general rules of symbol manipulation coded in the device which prints or erases symbols on the tape vs. the tape instructions, respectively.) Furthermore, the word "information" comes from the Aristotle-Aquinas' notion of "form": we are "informed" if new forms are added to the receptive intellect. Even semantically, the information theory of the soul is the same as the Aristotle-Aquinas' theory.

The point I am trying to make is that in a sense the mind-as-a-program idea is just old wine in a new bottle; it poses no challenge to the traditional view of the physical nature of man. But thinking of the human mind as a computer program, and more generally, regarding all thought as a species of information processing, is a conceptual advance of enormous significance, for it allows us to turn many philosophical problems about the scope and limits of human thought (or the thought of any possible intelligent being, for that matter) into formal problems of mathematical computer theory. For example, new light is thrown on the old issues of reductionism vs. irreductionism and determinism vs. indeterminism by thinking what these mean to a computer (see Section 3.2 of ACP for more discussion). More importantly, in the language of information processing, it becomes possible to say precisely what it means for life to continue forever. I shall say that "life" can continue forever if: (1) information processing can continue indefinitely along at least one world line  $\gamma$  all the way to the future "boundary" of the universe — that is, until the end of time; (2) the amount of information processed between now and this future boundary is infinite in the region of spacetime with which the world line  $\gamma$  can communicate; (3) the amount of information stored at any given time  $T$  within this region can go to infinity as  $T$  approaches its future limit (this future limit of  $T$  is finite in a closed universe, but infinite in an open one).

The above is a rough outline of the more technical definition given in Section 10.7 of ACP. But let me ignore details here. What is important is the physical (and ethical!) reason for imposing each of the above three conditions. The reason for condition 1 is obvious; it simply states there must be at least one history in which life (= information processing) never ends.

Condition 2 tells us two things. First, that information processed is "counted" only if it is possible, at least in principle, to communicate the results of the computation to the history  $\gamma$ . This is important in cosmology, because in most model universes event horizons abound. In the Friedmann universe, every comoving observer at some point loses the ability to send light signals to every other comoving observer, no matter how close. Life obviously would be impossible if one side of one's brain became forever unable to communicate with the other side. Life is organization, and organization can only be maintained by constant communication between the different parts of the organization. The second thing condition 2 tells us is that the amount of information processed between now and the

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end of time is potentially infinite. I claim that it is meaningful to say that life exists *forever* only if the number of thoughts generated between now and the end of time is actually infinite. But we know that each "thought" corresponds to a minimum of one bit being processed. In effect, this part of condition 2 is a claim that time duration is most properly measured by the thinking rate, rather than by proper time as measured by atomic clocks. The length of time it takes an intelligent being to process one bit — to think one thought — is a direct measure of "subjective" time, and hence is the most important measure of time from the perspective of life. A person who has thought 10 times as much, or experienced 10 times as much (there is no basic physical difference between these options), as the average person has in a fundamental sense lived 10 times as long as the average person, even if the chronological age is shorter than the average.

The distinction between proper and subjective time crucial to condition 2 is strikingly similar to a distinction between two forms of duration in Thomistic philosophy. Recall that Aquinas distinguished three types of duration. The first was *tempus*, which is time measured by change in relations (positions, for example) between physical bodies on Earth. *Tempus* is analogous to proper time; change in both human minds and atomic clocks is proportional to proper time, and, for Aquinas also, *tempus* controlled change in corporeal minds. But in Thomistic philosophy, duration for incorporeal sentient beings — angels — is controlled not by matter, but rather by change in the mental states of these beings themselves. This second type of duration, called *aevum* by Aquinas, is clearly analogous to what I have termed "subjective time." *Tempus* becomes *aevum* as sentience escapes the bonds of matter. Analogously, condition 2 requires that thinking rates are controlled less and less by proper time as *T* approaches its future limit. *Tempus* gradually becomes *aevum* in the future. The third type of Thomistic duration is *aeternitas*: duration as experienced by God alone. *Aeternitas* can be thought of as "experiencing" all past, present, and future *tempus* and *aevum* events in the universe all at once.

Condition 3 is imposed because, although condition 2 is necessary for life to exist forever, it is not sufficient. If a computer with a finite amount of information storage — such a computer is called a *finite state machine* — were to operate forever, it would start to repeat itself over and over. The psychological cosmos would be that of Nietzsche's Eternal Return. Every thought and every sequence of thoughts, every action and every sequence of actions, would be repeated not once but an infinite number of times. It is generally agreed (by everyone but Nietzsche) that such a universe would be morally repugnant or meaningless. Augustine argued strongly in Book Twelve of *The City of God* that Christianity explicitly repudiates such a world view: "Christ died once for our sins, and rising again, dies no more."<sup>6</sup> The Christian cosmos is progressive. Only if condition 3 holds in addition to condition 2 can a psychological eternal return be avoided. Also, it seems reasonable to say that "subjectively", a finite state machine exists for only a finite time, even though it may exist for an infinite amount of proper time and process an infinite amount of

data. A being (or a sequence of generations) that can be truly said to exist forever ought to be physically able, at least in principle, to have new experiences and to think new thoughts.

This raises a fundamental problem for the view of eternal life held by many Christians. There is no question but that an individual human being is a finite state machine. His brain is limited in the number of memories it can store. We are unaware of this because a rough calculation shows we would have to live at least a thousand years before the limit of capacity would be reached at the maximum memory storage rate recorded in psychological experiments. However, a thousand years is but an infinitesimal fraction of eternity (defined as infinite subjective time). It is possible to have only a finite number of new thoughts and new experiences after being raised from the dead at the Last Judgement. At normal subjective time rates, only a thousand years worth of new experiences are possible if the old memories are retained. It is logically impossible for "eternal" life to be eternal in an experiential sense, unless we imagine the fundamental finiteness of humanity is abolished upon resurrection. This is no solution, for a being which has and uses a potentially infinite memory would be utterly non-human. Our humanity is defined in part by our basic limitations. A finite memory is one of these.

Implicit in the above argument is the idea that living, feeling, thinking, etc., necessarily involve a change from one state to another. This is a definite consequence of the mind-as-a-program concept. But I claim it is a reasonable consequence. Consider a standard science fiction scenario, that of placing a person in suspended animation. No mental or any other changes occur to the person while she is frozen solid. Consistent with this lack of change, I will suppose that in fact the person when revived remembers nothing of the period while in suspended animation. Question: was that person "alive" while in suspended animation? Certainly the program that codes personality was not running during that time. That person was quite literally in limbo while in suspended animation. I claim there was no self-awareness during that time, because self-awareness means analyzing a mental model you have of yourself, and analyzing means mental change. That person was dead by most current legal definitions during the suspended animation period, for these definitions are based on neurological or other bodily activity (i.e., change of some sort). Nevertheless, I would conjecture that most people would be reluctant to consider her dead, because she was by assumption reanimated. But what if she were *never* reanimated? Suppose for some reason we discover we can't reanimate her even in principle. Even if the program which coded her personality were never erased, his self-awareness, by assumption, would never return. Isn't this what we mean by death? Isn't this the actual state — the lack of self-awareness for all future time — that the legal definitions of death are attempting to capture? So a program that cannot change, that is forever static in principle, cannot be a person no matter how complex it is. Nor can it be "intelligent" in any meaningful sense, because the essence of intelligence<sup>7</sup> means the ability to learn from experience, and this again is a species of change, of information processing.

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Let us now consider whether the laws of physics will permit life/information processing to continue forever. Von Neumann and others have shown that information processing (more precisely, the irreversible storage of information) is constrained by the first and second laws of thermodynamics. Thus the storage of a bit of information requires the expenditure of a definite minimum amount of available energy, this amount being inversely proportional to the temperature. (See Section 10.6 of ACP for the exact formula.) This means it is possible to process and store an infinite amount of energy between now and the final state of the universe only if the time integral of  $P/T$  is infinite, where  $P$  is the power used in the computation, and  $T$  is the temperature. Thus the laws of thermodynamics will permit an infinite amount of information storage in the future, provided there is sufficient available energy at all future times.

What is "sufficient" depends on the temperature. In the open and flat ever-expanding universes, the temperature drops to zero in the limit of infinite time, so less and less energy per bit processed is required with the passage of time. In fact, in the flat universes, only a *finite* total amount of energy suffices to process an infinite number of bits! This finite energy just has to be used sparingly over infinite future time. On the other hand, closed universes end in a final singularity of infinite density, and the temperature diverges to infinity as this final singularity is approached. This means that an ever increasing amount of energy is required per bit near the final singularity. The amount of energy required per bit actually diverges to infinity at the singularity. However, most closed universes undergo "shear" when they recollapse, which means they contract at different rates in different directions (in fact, they spend most of their time *expanding* in one direction while contracting in the other two!). This shearing gives rise to a radiation temperature difference in different directions, and this temperature difference can be shown to provide sufficient free energy for an infinite amount of information processing between now and the final singularity, even though there is only a *finite* amount of proper time between now and the end of time in a closed universe. Thus, although a closed universe exists for only a finite proper time, it nevertheless could exist for an infinite subjective time.

But although the laws of thermodynamics permit conditions 1 through 3 to be satisfied, this does not mean that the other laws of physics will so permit. It turns out that, although the energy is available in open and flat universes, the information processing must be carried out over larger and larger proper volumes. This fact ultimately makes impossible any communication between opposite sides of the "living" region, because the redshift implies that arbitrarily large amounts of energy must be used to signal (this difficulty was first pointed out by Freeman Dyson). This gives the *first testable prediction* of the Omega Point Theory: *the universe must be closed.*

However, as I stated earlier, there is a communication problem in most closed universes — event horizons typically appear, thereby preventing communication. However, there is a rare class of closed universes which doesn't have event horizons, which means by definition



There is another way to view this formal equivalence of all spacetime and the Omega Point. In effect, all the different instants of universal history are collapsed into the Omega Point; "duration" for the Omega Point can be regarded as equivalent to the collection of all experiences of all life that has, does, and will exist in the whole of universal history, together with all non-living instants. This "duration" is very close to the idea of *aeternitas* of Thomistic philosophy. We could say that *aeternitas* is equivalent to the union of all *aevum* and *tempus*. If we accept my earlier argument that life and personhood involve change by their very nature, then this identification appears to be the only way to have a Person who is omniscient, and hence whose knowledge cannot change: omniscience is a property of the necessarily unchanging, not-in-time, final state, a state nevertheless equivalent to the collection of all earlier, non-omniscient changing states.

Thus the indefinitely continued existence of life is not only physically possible; it also leads naturally to a model of an evolving God.

#### 4. *Is There Only One Possible Physical Universe?*

The idea that there may be only one logically possible actually existing universe is an old idea. Hume (or perhaps I should say, Philo) briefly toyed with it in his *Dialogues on Natural Religion*. Einstein often said that he became a physicist in order to find out "if the dear Lord had any choice when he created the universe." But it is only in the last few years, with the advent of the superstring theories, that the possibility of universal uniqueness began to be seriously discussed.

Now any philosopher of science can tell you that this idea is complete nonsense. Any scientific theory, indeed any logical system, is based on axioms which are themselves unjustified. Thus further scientific advance is always possible, for the axioms of the present day science can always be found to be consequences of even more fundamental axioms, and so on *ad infinitum*. A philosopher will tell you that one can always find alternatives to the present day theories which will account for the observations we have, just as well as the theories which are generally accepted by scientists. In other words, the axioms used to describe current observations are far from unique, if for no other reason than that we know very well the observations are not absolutely precise. Unavoidable experimental errors allow alternative theories, since many theories will be consistent with the data. The philosopher might also point out that physicists have occasionally claimed in the past they had the ultimate theory, only to see their world view collapse like a house of cards. So why do we find many famous contemporary physicists proclaiming that a unique physical theory is not only possible, but just around the corner?

The basic reason is that it is easy to say one can always find an alternative theory. It is extraordinarily hard to actually go out and find one. The database of observations is now so enormous that it is exceedingly difficult to construct a mathematical theory which is even roughly in agreement with experiment and which is fully self-consistent and universal.

The self-consistency problem is the most suggestive. It manifests itself primarily in the problem of infinities in quantum field theory. Almost all quantum field theories one can write down are simply nonsensical, for they assert that most (or all) observable quantities are infinite. Only two very tiny classes of quantum field theories do not have this difficulty: finite quantum field theories and renormalizable quantum field theories. Even before superstring theories became a major area of study, Steven Weinberg stressed how exceedingly restrictive the requirement of renormalization really is. It is really the renormalizability of Yang-Mills quantum fields that caused particle theorists to concentrate attention on this class of theories almost exclusively when attempting to model matter. But there is a countable infinity of possible renormalizable Yang-Mills theories. Any compact Lie group defines one. The Lie group  $SU(2) \times U(1)$  gives the Weinberg-Salam unified theory of the weak and electromagnetic interactions, and  $SU(3)$  correctly describes the color force which binds nuclei. But these Lie groups were picked out of the pack by experiment, not by logic. Still, this is considerable progress. We now have consistent theories for three of the four known forces. Unfortunately, general relativity, which is the standard theory of gravity, the fourth force, gives a non-renormalizable theory. Furthermore, even the renormalizable field theories have not completely eliminated the nonsensical infinities; they have really only succeeded in hiding them from view.

This is where superstrings come in. Green and Schwarz were able to show in 1985 that, in the context of the standard way of adding Yang-Mills fields to superstring theories, only *two* Lie groups,  $E_8 \times E_8$  and  $SU(32)$ , would give a consistent theory. And as a bonus, these theories were not merely renormalizable, they were actually *finite!* (to first order, anyway; there are pious hopes that the theories are finite to all orders). It also appears that gravity and the other three forces are present in the low energy limit of superstring theories. Now this is real progress! Full mathematical self-consistency has reduced the range of possible theories from the countable infinity of the possible Yang-Mills theories to a mere two candidates.<sup>9</sup> Self-consistency is also important in other ways in superstrings.

The trend is clear. The more forces and phenomena we try to include in a single theory, the less freedom we have to construct one. And, side by side with this shrinking range of possible consistent theories, there are fewer and fewer phenomena not included in the theory. There are actually physical arguments to show that we may have seen most of the fundamental phenomena, in contrast to the situation at the end of the nineteenth century. For example, all known elementary particles (fermions) can be grouped into what are called "families". If there were more than about 4 families, the synthesis of elements in the Big Bang would be different from what it is observed to be. And we have already observed 3 families.

Is it any wonder many physicists have come to believe that this process of fitting a larger and larger set of possible data points to a smaller and smaller number of self-consistent theories will converge on a single unique physical theory, a Theory of Everything (TOE)?

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A number of people have claimed that the Gödel incompleteness theorem shows a TOE cannot be true necessarily and *a priori*.<sup>10</sup> I think this claim is incorrect. Gödel has indeed proven that any theory which is sufficiently complex to contain all of arithmetic cannot be proven consistent by arguments inside the theory itself. But this just means that a self-justifying TOE must be simpler than the full theory of arithmetic. There are in fact branches of mathematics which can be proven decidable and consistent by reference to the branch itself. For examples, Euclidean geometry was proven decidable by Tarski and hyperbolic geometry was proven decidable by Schwabhäuser.<sup>11</sup> Nagel and Newman have given a proof of consistency of an important part of logic, the sentential calculus, or logic of propositions, in their popular-level book *Gödel's Proof*.<sup>12</sup> Even arithmetic with addition only can be proven decidable. It is quite possible that the TOE could lie in one of the decidable branches of mathematics.<sup>13</sup>

The important role self-consistency has played in the search for the TOE is one reason for believing that the TOE, if found, will be the only one logically possible. But it is not the only reason. After all, the TOE is so hard to find because it has to account for so many things. Why couldn't the universe have been much simpler? There are two answers to this question, both involving the Anthropic Principle. I shall give only one answer here,<sup>14</sup> the answer which involves an analysis of what the word "existence" means.

A thing can be said to exist only if it or its effects can be detected in some way. But the word "detected" itself presupposes the existence of something to do the detecting. Now an analysis of just what detecting or measuring means in physics shows that a measurement is carried out only if some piece of information is recorded. This in turn implies that a universe must be complex enough to permit the recording of information before it can have observers of any sort. In the ACP, Barrow and I devote some 400 pages to showing just how enormously complex this apparently simple requirement that observers exist within it makes the universe. In a nutshell, the universe must be as complex as it actually is in order to have observers of our complexity. Since we humans are not really *that* complex, this suggests it must be almost as complex as it is in order to have observers of any sort.

This brings us to the age-old philosophical problem of whether a universe which has no observers in it — and which has no detectable effect on a universe which does contain observers — can possibly be said to exist. My own inclination would be to say no, because there is no way I can say that anything inside such a universe exists; it is not possible to give meaning to the word "existence" in such a context. So with this understanding of the word "existence", it is quite plausible that only one Universe is logically possible — i.e., capable of existence — and we're in it. It is interesting that from this view of what existence means, it is the observers, or rather the possibility of observers and their observations, that permit the universe to exist. In a sense, the creatures inside the universe create both the universe and themselves.

Even if only one universe is logically possible, this does not mean that this unique universe actually exists. It would seem that a further assumption is required: the assumption that something exists. A reasonable assumption, to be sure, but nevertheless an additional assumption. However, it is not clear to me this additional assumption is actually required. Barrow and I develop at some length in Section 3.5 of ACP the fascinating idea that a perfect computer simulation of a universe would be indistinguishable from the real universe it simulates.<sup>15</sup> Now a simulation is just a sequence of natural numbers, and all sequences of natural numbers have mathematical existence, even though they may never have achieved the privilege of an actual physical representation in our actually existing physical universe. But if one of these corresponds to a perfect simulation of our physical universe, then as far as the humans simulated in the program can tell, it is real. Our copies behave no differently than we ourselves. Thus the existence (in the mathematical sense of the word) of these sequences of numbers is ultimately indistinguishable from existence in a physical sense, and mathematical existence comes ultimately from the laws of logic themselves!

In other words, the universe may very well be, in John Wheeler's phrase, a self-excited circuit. It may necessarily exist in its own right. *If* it does so exist — and I emphasize the word "if", because there are many gaps in the above argument — then the God whose existence is asserted by the cosmological/ontological argument, the wholly other God of Barth, and more generally any God who does not need the universe as much as the universe needs him, is quite superfluous. And further, this sort of God is superfluous in answering the very question for which his existence is invoked: why is there something rather than nothing; why *this* universe rather than some other universe?

##### 5. The Implications of the Omega Point Theory

My favorite definition of "religion" appeared in an article by Miller and Fowler published in the *CTNS Bulletin*: "'Religion' and 'theology' are taken to refer to the following: anything is religious which is concerned with the meaning of personal place; and theology is interpretative reflection on and explicit articulation of the meaning of personal place."<sup>16</sup> Perhaps I like this definition because it turns the paper you are now reading, the ACP, and even Darwin's *The Origin of the Species* into religious tracts! But is this definition really that different from Tillich's view<sup>17</sup> that religion, in the widest sense of the word,<sup>18</sup> is that which deals with questions of "ultimate concern"?

Certainly "personal place" was the central focus of the preceding two sections: in Section 3 the existence of an evolving God was inferred from the naturalistic ethical postulate that it must be possible for life never to die out in the universe, while in Section 4, it was argued that perhaps this never-dying life was, is, and shall be collectively responsible for the necessary existence of the universe itself (including the life within it). If the argument of Section 4 is accepted, then the ethical postulate of Section 3 is

unnecessary; but the necessarily collective of living things as inextricably bound

Humankind link; we cannot not possibly survive future. The history the total history evolve on Earth unbroken chain. planet. As we have long since extinct from us. And before the Omega Point

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unnecessary; both it and the evolving God can be inferred as properties of the necessarily existing universe — but this universe owes its existence to the collectivity of (past, present, future) living things, and the collectivity of living things is the evolving God! The created and the Creator are inextricably bound up in one another.

Humankind's place in the scheme of things is that of an intermediate link; we cannot expect our species, *Homo sapiens*, to live forever. We could not possibly survive the great cold and great heat that await life in the far future. The history of life on the Earth to date is a preview of what will be the total history of life in the universe: all individual living species that evolve on Earth eventually become extinct, but life itself goes back in an unbroken chain, more than 3.5 billion years long, to the early youth of our planet. As we humans are descended from simpler one-celled organisms, long since extinct, so beings more complex than *Homo sapiens* will descend from us. And beings still more complex will in turn descend from them, up to the Omega Point.

This picture of the chain of life is strikingly similar to the medieval and Enlightenment view of life, which the famous historian of ideas Arthur O. Lovejoy termed "The Great Chain of Being."<sup>19</sup> In this view, all living things were arranged in a vast *static* hierarchy, with inorganic materials at the bottom, followed by plants and animals, mankind in the center, the angels higher still, and with God at the top. The Omega Point Theory is essentially a temporalized version of The Great Chain of Being. Not surprising, because as I emphasized in Section 3, life is fundamentally a temporal phenomena; this same insight is what underlies Darwin's *Origin of the Species*. "Origin" is itself a temporal word.

This temporally progressive Chain of Being, with one species being ultimately replaced by another coding more information (this is what is meant by "more complex" or "more advanced") is a consequence of the assumption of "progress" which is built into conditions 1 through 3 of Section 3. Our own species has limits; there is a limit to the knowledge that can be coded in a human brain. So if knowledge is to continue to increase, indeed to increase without limit, it must one day be coded in other than human brains. Judging from the present rapid development of computers, I would guess that our successor species will be quite literally "information processing machines," machines with minds superior to ours. Perhaps the molecular biologist Manfred Eigen is correct in saying that DNA reaches with *Homo Sapiens* the limit of the complexity it can code. If so, if life is to gain in complexity and knowledge is to increase, then the leading shoot of life must move from one substrate — DNA — to another. Certainly this move must occur at some point in the future, because DNA-based life cannot survive in the high temperature environment near the final singularity. The extinction of our species is required both by the laws of physics and the inherent logic of eternal progress. But this should not horrify us. All religions agree that what is ultimately important is the eternal continuation of intelligent personality (ultimately God's), not the particular racial form it happens to take. If the Omega Point Theory is true, life shall not perish from the Cosmos, but shall grow into the Omega Point.

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<sup>1</sup> In 1909 the universe at the beginning of the creation story. Pope Pius XII's Big Bang theory and Religion (New York: Basic Books, 1954) of the Roman Catholic position, although it is not Catholic dogma. A Catholic dogma is the Resurrection of Christ, which is the basis of Christianity: as St. Thomas Aquinas would believe in any Christian belief on a matter of fact — the Resurrection — the Resurrection. For St. Thomas, the Resurrection is a miracle, and also a sign of the natural order. For St. Thomas, the Resurrection would be a bad thing for biographers, individuals, and the Cosmos: error. But collective eternal life.

St. Augustine's far-reaching implications of his book of *The City of God* implied that one who dies again, dies no more. Science to tell us the truth, re-interpreted metaphysics. re-interpretation. rather than in the natural order. See McMullin's essay.

<sup>2</sup> John D. Barrow (Oxford: Oxford University Press, 1988). Frank J. Tipler. *ES* 21-37.

<sup>3</sup> Francisco J. Ayres by Francisco J. Ayres (Chicago Press, 1974).

<sup>4</sup> Eric Delsing.

<sup>5</sup> D. R. Hofstadter (1981), is the best example of the presence of a mind. John Searle and Dennett won hands. Dennett won hands. computer power of



## NOTES

<sup>1</sup> In 1909 the Pontifical Biblical Commission listed the creation of the entire universe at the beginning of time as one of the "fundamental truths" of the Genesis creation story. Pope Pius XII claimed in a major address delivered in 1951 that the Big Bang theory supported Catholic doctrine. See I. G. Barbour, *Issues in Science and Religion* (New York: Harper Row, 1971) 373-375, for a discussion of this view of the Roman Catholic position. It should be emphasized, however, that this position, although held by many influential Catholics, cannot be considered Catholic dogma. Although this position on the beginning of the Universe is not Catholic dogma, there are scientific-historical statements, such as the Resurrection of Christ, which definitely are. See Anthony Kenny, *A Path from Rome* (Oxford: Oxford University Press, 1986). And the Resurrection is the scientific foundation of Christianity: as St. Paul himself emphasized, if Christ did *not* rise from the dead, belief in *any* Christian tenet is in vain. Christianity rests, as do the natural sciences, on a matter of fact; Christianity *requires* that at least one "gap" in the natural order — the Resurrection — occurred in the past. I personally do not believe in the Resurrection, for reasons succinctly stated by David Hume in his work *On Miracles*, and also because I am an ontological reductionist: there are *no* gaps in the natural order. Furthermore, I think eternal life for an individual human being would be a bad thing, for reasons stated in Section 3. As Hume said to one of his biographers, individual eternal life would just lead to an accumulation of garbage in the Cosmos: errors and crimes made by individuals would *never* be forgotten. But collective eternal life can lead to unlimited progress.

St. Augustine recognized that the Resurrection, *qua* scientific fact, had far-reaching implications for scientific cosmology. The second half of the twelfth book of *The City of God*, devoted to showing the *uniqueness* of the Resurrection, implied that one of the central assumptions of Greek science, namely the Eternal Return, could not possibly be true: "For Christ died once for our sins, and rising again, dies no more." Thus, although Augustine was willing to allow natural science to tell us that some *unimportant* (for redemption) Biblical passages must be re-interpreted metaphorically, the Resurrection was definitely *not* open to such re-interpretation; rather, for Augustine, the Resurrection was an uncloseable "gap" in the natural order, and any acceptable scientific theory must be consistent with it. See McMullin's essay in this volume.

<sup>2</sup> John D. Barrow and Frank J. Tipler, *The Anthropic Cosmological Principle* (Oxford: Oxford University Press, 1986); hereafter referred to as ACP. See also Frank J. Tipler, *Essays in General Relativity* (New York: Academic Press, 1980) 21-37.

<sup>3</sup> Francisco J. Ayala, "Introduction," in *Studies in the Philosophy of Biology*, by Francisco J. Ayala and Theodosius Dobzhansky (Berkeley: University of Chicago Press, 1974).

<sup>4</sup> Eric Delson, "One Source, Not Many," *Nature* 325 (1988) 206.

<sup>5</sup> D. R. Hofstadter and D. C. Dennet, *The Minds I* (New York: Basic Books, 1981), is the best and most complete defense of the Turing Test as a test for the presence of a mind. This book provoked an exchange between the philosopher John Searle and Dennet in the pages of *New York Review of Books* over the validity of the Turing Test. I recommend reading this exchange, although I think Dennet won hands down. Searle simply cannot understand the enormous effective computer power of the human brain ( $10^{10}$  to  $10^{15}$  bits of memory and a



proposal for avoiding the democracy-is-impossible implications of the Arrow Impossibility Theorem. According to this Theorem, no social welfare function — a procedure for deciding which alternatives (among economic goods, among political leaders, among religions, etc.) society as a whole should choose — exists which satisfies four assumptions. The first assumption is nondictatorship: the social welfare function cannot consist of picking a single person (the dictator) and letting this person decide what the whole society will choose. The second is independence of irrelevant alternatives: if the social welfare function implies alternative A is preferred to alternative B, then a change in individual preferences which does not change any one individual's preferences between A and B cannot change the social choice of A over B. The third is that society cannot switch from A to B if a single individual switches in the other direction from B to A. That is, if more individuals start to prefer A to B, then the choice of society as a whole cannot switch in the opposite direction. Finally, the social welfare function must be consistent (transitive): If A would be chosen over B, and B over C, then A must be chosen over C. See Paul A. Samuelson, "Arrow's Mathematical Politics," in *Human Values and Economic Policy*, by Sidney Hook (New York: New York University Press, 1967) 41-51. For the Arrow Impossibility Theorem see David Friedman, *Price Theory* (Cincinnati: South-Western Publishing, 1986) and Jerry S. Kelley, *Arrow Impossibility Theorems* (New York: Academic Press, 1978).

<sup>14</sup> The other answer involves the Participatory Anthropic Principle, which was invented by John A. Wheeler. It draws on the Copenhagen Interpretation of quantum mechanics, which holds that many of the properties subatomic particles exhibit are determined by the observer's choice of what to measure. Following the logic of this interpretation, Wheeler conjectures that *all* the properties of *all* the particles in the universe are determined by the collection of all the acts of observer-participancy in the past, present, and future. In particular, these acts collectively bring into existence all the observers themselves. Thus in this answer also, the creatures collectively are responsible for creating the entire universe and themselves. But in this answer, the creation is more direct; the word "creation" is used in a sense closer to its everyday usage. See the ACP index for references to the Participatory Anthropic Principle. See also John Wheeler, "Probability And Determinism," *IBM Journal of Research and Development* 32 (1988) 4-15. He points out that the Participatory Anthropic Principle presupposes the Omega Point Theory, for only the enormously more powerful observer-participants of the far future can interact on the scale necessary to bring our enormous universe into existence.

<sup>15</sup> See also Douglas R. Hofstadter and Daniel C. Dennett, *The Mind's I* (New York: Basic Books, 1981).

<sup>16</sup> James B. Miller and Dean R. Fowler, "What's Wrong With the Creation/Evolution Controversy?" *CTNS Bulletin* 4 (Autumn 1984) 1-13.

<sup>17</sup> Paul Tillich, *The Dynamics of Faith* (New York: Harper and Row, 1957).

<sup>18</sup> See I. Barbour, 1971, *op. cit.*, 219, for a detailed discussion.

<sup>19</sup> Arthur O. Lovejoy, *The Great Chain of Being* (Cambridge, Mass.: Harvard University Press, 1936).