Tegmark's Parallel Universes: A Challenge to Intelligent Design?

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1. Introduction

In an article entitled "Parallel Universes" in the May 2003 issue of *Scientific American*, Max Tegmark presents a clear and comprehensive picture of the parallel-universe idea. What Tegmark describes is actually a set of related concepts which have in common the notion that there are universes beyond the familiar observable one that astronomers can see parts of directly with telescopes and other instruments. Some of these parallel universes are completely unlike our own; others are nearly identical; still others are identical up to a point and then split off into might-have-been worlds of choices not made. Tegmark's main argument is that, far from being a shadowy, speculative corner of cosmology, the parallel-universe idea has been increasingly confirmed by recent experiments, and we should get used to it because it appears that it will be around for a while.

If true, this is not good news for proponents of intelligent design such as William A. Dembski. In his recent book *No Free Lunch*, Dembski is at considerable pains to show why the parallel-universe idea is basically a non-starter. He recognizes the threat that parallel universes pose to the concept of specified complexity. Simply expressed, if literally anything can happen, it will, including the most unlikely and designed-looking things such as earth, life, and humanity. If certain forms of the parallel-universe idea are true, then chance, not design, becomes omnipotent.

Cosmology has always bordered upon metaphysics. Questions of ultimate origin and destiny began as metaphysical questions, and only in the last century has science begun seriously to address some of these issues with theories based on empirical evidence. It is still not always easy, therefore, to distinguish cosmology based on empirical evidence from a philosophical position disguised as empirical cosmology. As we shall see, Tegmark's article deals largely with theories whose main feature, namely, multiple universes, cannot be verified by observation or experiment *even in principle*. The experimental tests he proposes for these theories really consist in making the philosophical presuppositions required for believing in the theories, and then verifying that the theories agree with already-known data about the present visible universe. So far from being a legitimate way to inflate probabilistic resources to defeat arguments in favor of intelligent design, Tegmark's parallel universes represent an array of philosophical arguments disguised as science. While the philosophical arguments may have merit on their own, it is illegitimate to claim that they are empirically verified in the conventional scientific sense, as Tegmark sometimes does.

2. Tegmark's Parallel Universes: Starting Points

The article in question is featured on the cover of *Scientific American* with the headline "Infinite Earths in PARALLEL UNIVERSES Really Exist." This headline is posed against a background of infinitely receding cosmological balls of stars with the earth and the moon in the center of each. One should not hold an author responsible for the deeds of his editors, but clearly the editors feel that the parallel-universe idea is attractive to the kinds of readers they want: intelligent, secular, and somewhat skeptical. It should be noted in passing that over the last twenty years, *Scientific American* has changed from a dignified publication dedicated to bringing high-quality summaries of the best scientific work to the intelligent lay reader, to a journal of combined reporting and opinion which unabashedly advocates the scientism line. As evidence of this change, professional skeptic Michael Shermer now writes a monthly column for the magazine. So it is not surprising that a certain bias in the direction of scientism is to be found in nominally "straight" articles as well.

To his credit, Tegmark does not go as far as the lurid cover suggests he does. He refuses to state categorically that the evidence for parallel universes is as good as the evidence that, say, George W. Bush is the current President of the United States. He hedges his assertions with adjectives like "probably" and "likely," and carefully admits that some of his conclusions are controversial within the scientific community. Nevertheless, the overall picture he draws is quite a convincing one, given his assumptions.

What are these assumptions? Unlike earlier uniformitarians who assumed the validity of known physical laws everywhere, Tegmark does not do so. In fact, one of his parallel-universe ideas allows for the possibility of universes where physical laws are widely at variance with those we are familiar with: places with more or fewer dimensions of space and time, places where energy and matter take on unfamiliar forms, and so on. One thing he does appear to take very seriously is the validity of thought–in particular, mathematical thought. This is an understandable attitude for a theorist to take, and one which is a welcome change from many postmodernists who reject the validity of thought at the outset.

A second thing he takes seriously is experimental data pertaining to cosmology. In particular, one of the main empirical starting points for his article is some recent data obtained from the WMAP satellite. WMAP is a microwave anisotropy probe designed to measure extremely small variations in the cosmic microwave background radiation. This radiation was predicted by cosmologists and then discovered in the 1960s by Penzias and Wilson of Bell Laboratories. It is a weak but measurable type of microwave radiation left over from the Big Bang. Buried within it are details about the nature of the universe as it was shortly after it came into existence. It will be well to begin the discussion of Tegmark's ideas with that data and work from there, because the validity of both thought and experimental data are two things upon which all parties to the discussion will agree.

Unlike many earlier measurements of background radiation, the WMAP satellite can resolve features with an angular extent as small as 0.2 degrees. It can also measure differences in radiation strength as small as a few millionths of a degree Kelvin. It turns out that on these small, fine-grained scales, the background radiation has irregularities that change in magnitude as the angular scale decreases. Viewed at a scale of 20-degree-wide features, there is relatively little difference in radiation intensity in different directions. But as the effective “zoom lens” of the satellite looks at smaller and smaller features, it turns out that the differences peak at a scale of about half a degree. In other words, the background radiation looks lumpiest when you view it through a virtual microwave telescope that covers half a degree of angular view. And the peak is quite significant: 80 microkelvins as opposed to 30 to 40 microkelvins in the rest of the angular ranges.

That is the uncontroversial data. The questions arise when we try to say what it means. And what it means has great implications for the nature of the universe.

3. A Brief History of Cosmology

A brief history of the scientific conceptions of the universe is in order here. As Ronald W. Clark recounts in *Einstein: The Life and Times*, the medieval idea of a finite universe with the earth at the center (or perhaps more precisely, the bottom) gave way in the seventeenth century to the infinite, static universe of Newton in which star-populated space extended infinitely in all directions. For various reasons, this fell out of favor in the nineteenth century and was replaced by an “island universe” in which space itself was infinite, but matter was concentrated in a particular volume near us.

When Einstein began to examine these pictures in light of his newly developed General Theory, he found that both the Newtonian and the island universes were inconsistent with his theory. His equations had two unknowns which had to be introduced from outside the system: the curvature of space and the total mass of the universe. Because Einstein felt that the universe should be “quasi-static” (that is, not expanding or contracting overall), he introduced a “cosmological constant” which made such a quasi-static universe consistent with a positive curvature of space. This positive curvature, required for other reasons, meant that although one could travel indefinitely inside the universe, the universe was finite (or closed) in the sense that eventually one would return to one’s starting point, although “eventually” might be billions of years.

It is important to remember that at the time Einstein was developing his theory (1917), there was no experimental evidence for a rapidly expanding universe. Edwin Hubble discovered such evidence in the 1920s, and Einstein publicly withdrew his cosmological-constant “fudge factor” shortly thereafter.

The question remained, however, whether space was curved (and closed) or flat (and open). Tegmark’s claim is that the WMAP data strongly suggest that space is flat or at most slightly curved. The difference is between an unbounded but finite universe (which results from space having a positive curvature), and a truly infinite one (which results from space being geometrically flat). The problems with Tegmark’s arguments arise once one grants him his infinite universe.

Tegmark's argument proceeds as follows. If, as the WMAP data indicate, space is truly infinite, it is either an infinite void with a finite spot of matter near us (the old so-called "island universe"), or it is infinite with about the same amount of matter spread uniformly throughout it. He adduces both WMAP and other astronomical data which strongly suggest that the distribution of matter throughout the known (directly observable) universe is uniform. He then takes the critical step of extrapolating this observation throughout his putative infinite universe, which we cannot directly observe.

The reason we cannot directly observe it is that it lies outside our so-called "Hubble volume." Roughly speaking, a Hubble volume is a sphere centered on a point of observation, having a radius equal to the distance light can travel in an expanding universe in 14 billion years. Why 14 billion? That turns out to be the age of the universe, determined with better accuracy than ever from data produced by the WMAP satellite. The idea is that we can directly observe only those objects which lie within a Hubble volume centered on the Earth, because there has not been enough time since the beginning of the universe for light to travel from any farther distances to us.

This seems odd at first glance, because if one tries to imagine a simple, non-relativistic Big Bang, you would think that if matter can't travel faster than the speed of light, then how can the universe be any bigger than a single Hubble volume? There is an answer to this question. Hubble volumes are not constant in size. The earlier you go in the history of the universe, the smaller a given Hubble volume is, because the time involved is shorter and the distance is proportionally shorter. In *The Matter Myth*, Paul Davies and John Gribben point out that at a time of 10^{-35} seconds after The Beginning, a Hubble volume is only 10^{-25} cm in radius. But the universe as a whole was supposedly about 10^{-26} cm across, then inflated rapidly. So even that soon after the beginning of time, the universe as a whole was bigger than the Hubble volume which would eventually become ours. After inflation, each Hubble volume was separated from the others by expanding space and cannot possibly influence any other Hubble volume, because a signal would have to travel faster than the speed of light to do so. The point is that when we talk about the universe as a whole, we're talking about space itself, not light traveling through space. And while nothing can travel faster than the speed of light *relative to anything else*, space itself (with nothing in it) can expand in a way that appears to make parts of it travel at a speed greater than that of light.

Davies has a helpful section in his book called "Confessions of a Relativist" in which he describes his personal struggles with the sometimes bizarre concepts and phenomena which modern relativity theory and cosmology contain. He found his way around these difficulties by adopting a limited observer's-eye view of any given situation and by strenuously avoiding any attempt to look at the whole picture (the so-called "God's-eye view"). Only in this way, which he admits is a species of positivism, can he get his mind around the concepts that he must deal with as a theoretical physicist. But he believes that neither he nor anyone else, including an Einstein, can truly visualize some of the more peculiar concepts *in toto*.

This situation has a parallel in quantum mechanics when one asks of the outcome of a quantum-mechanical event: "Okay, we measured a particle, but what *really* happened?" The medieval scholastics were fond of asking questions about the essence of things: what is really the irreducible heart or core of a thing? In some cases, answers to such questions can be found. But the present resources of science, *as science*, are inadequate to give answers to such questions as, "When a uranium nucleus decays spontaneously at a particular time, why did it decay at that moment and not some other moment?" The most we can say is that the chances of seeing a decay are exactly so-and-so in such-and-such an interval. And cosmologically, we can say what particular observers might see at particular locations, but the question, "What does God see of it all?" is not one that science can answer.

But Tegmark seems to believe that science can say with a fair degree of certainty that the parallel universes of his theories are there, even though we can't see them. He arranges his article in sections which describe increasingly sophisticated and controversial versions of the parallel-universe idea, which he terms Levels I, II, III, and IV. Because there are different philosophical implications of each, we shall follow his arrangement as we examine his ideas.

Incidentally, Tegmark recognizes that some readers may be tempted to classify his ideas as something other than empirical science. Just before he begins his discussion of the various levels of multiverses, he asserts that the multiverse idea "fulfills both of the basic criteria of an empirical science: it makes predictions, and it can be falsified." We will bear these allegedly fulfilled criteria in mind as we examine each of his multiverse ideas in turn.

4. Tegmark's Level I Multiverse: As Uncontroversial As It Seems?

There are two basic assumptions Tegmark makes which allow the existence of the Level I multiverse, both grounded in empirical data. One assumption is that space is infinite, in the sense of "open" used above. Einstein's universe of positive curvature was closed, or finite. But Tegmark says that the WMAP data as well as other observations have thrown the picture of a closed universe into serious doubt: "Infinite models fit the data, and strong limits have been placed on the alternatives."

The second assumption is that this infinite space is filled with matter at more or less the same density as the matter we observe in the known universe (our local Hubble volume). Strictly speaking, this is a uniformitarian assumption. Strictly speaking, we know *absolutely nothing* from an observational or experimental viewpoint about what is going on outside our Hubble volume. Humbler scientists of the past would have simply ended their scientific papers at this point and said, "Of course, what lies beyond this region is in the realm of speculative philosophy, not science." But science has shown an increasing tendency in recent years to overstep its legitimate bounds in order to make pronouncements that earlier scientists were shy of making. Here we have an excellent example of this tendency.

Since, by definition, we cannot presently observe the space beyond our Hubble volume, this second assumption can never be directly tested. Already, Tegmark's claim that this aspect, at least, of the multiverse idea can be falsified is cast into doubt. Nevertheless, this critical assumption allows Tegmark to draw the conclusions which follow.

"Infinite" is a strong concept. As Dembski points out in *No Free Lunch*, "the moment one posits unlimited probabilistic resources, anything of nonzero probability becomes certain" (p. 95). Tegmark works this notion to the max, so to speak, and claims that since matter can be arranged in a single Hubble volume in only so many ways, the entire universe we know about must eventually repeat indefinitely like a pattern on a piece of wallpaper, if you simply go far enough to look for it. Moreover, he claims that there are universes even closer than that, in which smaller areas are like ours. If you go down to asking for duplicate areas only the size of a single human being, Tegmark claims that there is a döppelganger of you within only about 100 diameters of a single Hubble volume.

The most apposite comment I can make on this is attributed to Mark Twain: "There is something fascinating about science. One gets such wholesome returns of conjecture out of such a trifling investment of fact." The problem here is exactly what Dembski points it out to be: the moment one posits a truly infinite space filled with matter arranged in ways that are presumed to be random (which is yet another assumption which can never be empirically tested), then every possible arrangement of matter will occur, not just once, but an infinity of times. Since the observable universe, which includes this humble ball called Earth, is certainly one possible arrangement of matter, the fact that it has occurred once leads to an absolute mathematical certainty of its occurring an infinity of times in a truly infinite multiverse, given Tegmark's assumption of randomness.

Before we proceed to higher levels of Tegmark's multiverse structure, we should reiterate that this first level is based upon an assumption that is unwarranted by evidence and is in principle untestable: that there is matter arranged in every possible way beyond the visible limits of our universe. Yes, it looks like matter is distributed uniformly out to the edges of what we can see, but the assumption that this trend continues past that limit is (a) only an assumption and (b) untestable in principle. Therefore, what Tegmark is doing at this point is not "empirical science" as he claims, but is philosophy under another name. Philosophy is all very well, but it should be labeled as such, not prominently displayed on the cover of *Scientific American* as empirical science.

We have shown that Tegmark's Level I universe, far from being the result of empirical science, is based on an assumption which, while perhaps appealing, is not supported directly by any evidence, and in principle cannot be. What damage does this do to the higher-level multiverses?

5. Level II: Multiverses of Differing Dimensions

The picture Tegmark draws of the Level II multiverse is different enough from the Level I that we should examine it from scratch. Level II assumes, not the uniformitarianism of Level I, but the correctness of the inflationary hypothesis. This hypothesis, proposed by Alan Guth in the 1980s and widely adopted since then, says that shortly after the Big Bang, the universe expanded exponentially in a period called "inflation." The inflationary hypothesis explains a great many otherwise puzzling aspects of the observable universe, such as why matter is so relatively uniformly distributed and why the cosmic background radiation is basically uniform.

One important consequence of the inflationary hypothesis, says Tegmark, is that space is rapidly expanding forever, and our little part of it (including a Level I multiverse) is only a "bubble" in a set of widely separated areas which are traveling apart so fast that there is no hope of ever communicating with them, even in principle. In other bubbles than ours, the very number of dimensions and basic particles are different, because symmetry has broken down in a way differently than it did in our multiverse.

The argument Tegmark adduces for the existence of Level II multiverses is curious: it is basically a variation on the anthropic principle. Besides the fact that inflation accounts for many features of our visible universe, Tegmark says that because it proposes the existence of many other universes with different fundamental physical constants than ours helps explain away what is otherwise a peculiar "fine-tuning" of many of the constants in our particular universe. This fine-tuning consists of the particular values of a large number of constants such as the mass of the sun, the mass of the proton, the strength of the electromagnetic force, and so on. It turns out that if the values of any of these constants were substantially different (some by less than a percent), the consequence would be that life as we know it would be impossible.

Some physicists who are also theists see the hand of God in these "coincidences." But Tegmark prefers to say that if we let the Big Bang have a number of tries at getting all these constants right in the various "bubble universes" proposed by inflation, instead of just the one try that led to our universe, than the fact that all the fine-tuned constants are what they are becomes less of an oddity. This is a variation on the same inflated-probabilistic-resources argument used for the Level-I universe, but on a larger scale.

It is not clear from Tegmark's article whether the inflationary hypothesis *requires* the presence of "bubbles" or whether bubbles are just one version of alternate forms of the hypothesis. To the extent that inflation is confirmed by empirical data, it is an empirical scientific theory confirmed by experiment. One would have to research the topic of inflation more thoroughly to find out whether the bubbles are a necessary or merely optional part of the theory. Since most of the bubbles do not contain anything even remotely resembling our universe, they do not contribute to the inflation of probabilistic resources as much as the excess universes in the Level I universe theory do. But the fact that Tegmark uses them as probabilistic resources to say that our universe is, after all, nothing special, betrays a certain tendency of thought which is consistent with what he did with the Level I picture.

6. Level III: The Quantum Many-Worlds Multiverse

In a way, Tegmark's Level III multiverse is just Level I recycled with a vengeance. He starts, not with an experimental observation, but with Hugh Everett's famous many-worlds interpretation of quantum mechanics. Quantum theory began with an elegant mathematical structure which described the smooth, deterministic evolution over time of an entity called the wave function. One can write a wave function for a single particle, a set of particles, or (in principle) the entire universe. The only trouble is, to find out what really happens in the classical world of observable particles, one must "collapse" the wave function, taking its squared amplitude, to find the probability that a real event really occurs. This last step, although strictly speaking the only connection between quantum mechanics and the ordinary classical world, is messy and out of keeping with the elegance and determinism of the rest of the theory.

What Everett did was to show that the collapse of the wave function was unnecessary. All you have to do is to assume a vast number of parallel universes in which all sorts of classical events are occurring. The single quantum-mechanical wave function describes all of these universes and all possible outcomes of the events in them. When an observer in one of these universes performs a quantum-mechanical experiment and observes a particular outcome, the wave function doesn't really collapse, in Everett's view. The observer just switches tracks, so to speak, on a vast parallel-universe railroad switchyard of parallel tracks. On the new track, he sees the experiment turn out a certain way. On another track, his döppelganger sees the experiment turn out a different way, but both outcomes are consistent with the wave function.

Since every observable quantum-mechanical interaction at every instant gives rise to such splitting, the number of parallel universes quickly grows to fantastic proportions–basically to the same size as the number of multiverses in the Level I multiverse picture. Because, quantum mechanics or no, there are only so many ways to arrange a finite number of particles, in a truly infinite universe all of these arrangements are available at any time. Once Tegmark has established this picture, he quickly makes the brain-drives-the-mind move in the following passage:

> *Whenever observers are asked a question, make a snap decision and give an answer, quantum effects in their brains lead to a superposition of outcomes, such as "Continue reading the article" and "Put down the article." [From one perspective,] the act of making a decision causes a person to split into multiple copies: one who keeps on reading and one who doesn't. [From another perspective,] however, each of these alter egos is unaware of the others and notices the branching merely as a slight randomness: a certain probability to continue reading or not.*

At this point, Tegmark says that this picture requires the evolution of the wave function to be unitary, and says there is good evidence that it is. If this is true, then the Big Bang quantum fluctuations generated a grand wave function which was a quantum superposition of all possible initial conditions, and this amounts to really nothing more than the Level I multiverse. As he puts it, "In other words, the Level III multiverse adds nothing new beyond Levels I and II, just more indistinguishable copies of the same universes–the same old story lines playing out again and again in other quantum branches." He then goes on to speculate that there may be something significant in the fact that, given this picture, the evolution of time itself could be synthesized by switching rapidly from one universe to another, because all possible events over all time are contained somewhere in the grand-wave-function Level III universe.

There are several problems with this idea, especially bearing in mind that Tegmark claimed it was part of an empirical science which can make predictions and be falsified. Again, let us start with the items of likely general agreement and go from there.

No one is likely to question the practical efficacy of quantum mechanics. The computer on which I write this essay relies upon quantum effects for its operation. Nobody will deny that quantum mechanics appears to be one of the most accurate and successful empirically verified scientific ideas of all time. However, there are aspects of quantum mechanics which quickly move into the realm of philosophy. And one of these aspects turns out to be the interpretation of the wave function, which is exactly what Everett did with his many-worlds idea. In *No Free Lunch*, Dembski quotes Anthony Sudbery as saying, "An interpretation of quantum mechanics is essentially an answer to the question, 'What is the state vector?'" Asking that question is not unrelated to the question that the medieval scholastics were so fond of: "What is the essence of this thing?" And despite all its practical successes, quantum mechanics so far has refused to yield up a satisfactory philosophical interpretation which at the same time makes any practical difference in the predictions of quantum theory.

Although a number of different interpretations exist, they all appear to say the same thing about actual experiments. The way one interprets the state vector or the wave function will have not the slightest effect on one's answer to a practical quantum-mechanical problem. To find out what happens at the ordinary human scale, one must always allow decoherence, which is essentially the modern-day equivalent of the traditional collapse of the wave function. And at the human level, we do not find the slightest physical trace of the alleged split-off worlds that result when we flip a coin, make a particle measurement, or decide to have cornflakes for breakfast instead of toast.

There is, it is true, a vivid picture in most peoples' minds of the land of might-have-been. The facts that we can imagine alternative outcomes arising from contingent circumstances, and that this ability is a universal feature of human thought, may or may not be significant with regard to the many-worlds interpretation of quantum mechanics. But it is one thing to imagine such worlds as a whim, and quite another thing to assert their real existence as part of an empirically verified science. So, as we have seen, Tegmark's Level III multiverse amounts to a recycled Level I multiverse, which has already been shown to be on shaky empirical ground, to say the least.

7. Level IV: Back to Platonism?

In many ways, Tegmark's discussion of the Level IV multiverse is the most frankly philosophical part of the article. Tegmark's high estimation of the validity of thought comes into play here. He begins by citing the uncanny ability of mathematics to describe and predict features of the physical world. Physicists from Einstein to Eugene Wigner have cited this fact as one of the most mysterious aspects of physics. Tegmark then opposes two traditional philosophical worldviews as a way to illustrate his next point.

The first view, which he calls Aristotelian, takes physical reality as fundamental and mathematics as simply an approximation to physical reality. Everyone, he says, starts out in life as an Aristotelian. The second view, which he calls Platonic, is that the most fundamental aspect of reality is mathematics, and that what we see in the physical world is simply an approximation to the true underlying reality, which is actually mathematical.

This is pure philosophy, as Tegmark admits. Observe what Tegmark says next:

> *If the universe is inherently mathematical, then why was only one of the many mathematical structures singled out to describe a universe? A fundamental asymmetry appears to be built into the very heart of reality.*
>
> *As a way out of the conundrum, I have suggested that complete mathematical symmetry holds: that all mathematical structures exist physically as well. Every mathematical structure corresponds to a parallel universe. The elements of this multiverse do not reside in the same space but exist outside of space and time. Most of them are probably devoid of observers.*

Asserting that every mathematical structure has a corresponding physical reality outside of space and time is philosophy pure and simple. Obviously, no possible measurement or observation could ever verify or falsify the existence of such alleged entities. Yet Tegmark asserts that this Level IV multiverse makes testable predictions. But his test is of a curious kind.

What he proposes is for mathematicians to sit around and think up the full range of mathematical structures. Once that little job is done, then "they should find that the structure describing our world is the most generic one consistent with our observations." Somehow, Tegmark believes that this exercise constitutes an experimental test of his Level IV idea.

Let us propose a thought experiment. We will set a group of theologians to begin consideration of all possible descriptions of a Supreme Being. One of these descriptions, and one only, will consist of a being greater than any other being which could be conceived. If God is assumed to be greater than all other conceivable beings, then that one being which is greater than all the others must be God. If we conclude from this experiment that God exists, we will be following the lead of St. Anselm, who pursued a similar argument for the existence of God. I suspect Tegmark would not hold still a minute to listen seriously to St. Anselm's argument in favor of the existence of God. But his argument in favor of the existence of Level IV multiverses amounts to the same thing. He is in essence saying, "Because we can think of a mathematical structure, it must exist somewhere."

He leaves unstated the scientistic assumption which lies behind all his reasoning, which is that after all, there cannot really be anything so special about our universe. In order to avoid allowing for some sort of design or special-case circumstance, he wishes to posit entities which will allow our universe and its mathematical structure to be "just one of the boys" rather than a unique and hence statistically unexplainable artifact. It appears that this desire to de-specialize the universe lies behind the motivation for many, if not all, of the multiverses Tegmark describes.

8. Conclusions

We have seen how Tegmark's arguments in favor of multiverses, far from being "empirical science," are shot through with philosophical presuppositions which cannot in principle be verified by observations. Given unlimited probabilistic resources, anything not impossible is certain. This philosophical assumption, which Tegmark claims to be based on empirical data, is behind all his attempts to posit the existence of various universes outside our own. The enterprise of ascertaining specified complexity, on the other hand, always begins with an assumption that some things are unlikely enough not to occur. It is a much more practical, down-to-earth, and (pardon the expression) scientific way of proceeding. If one assumes an infinity of worlds, nothing that is not logically impossible is certain to occur, including the world we live in.

In fairness to Tegmark, it should be noted that he appears to consider the lines of thought expressed in his article somewhat controversial. On his personal website (www.hep.upenn.edu/~max/multiverse.html), he himself characterizes this *Scientific American* article with the word "wacky." A somewhat more serious-toned and technical companion article on the same subject will appear in a book entitled *Science and Ultimate Reality: From Quantum to Cosmos* later in 2003. Clearly, Tegmark realizes that he is doing more than straight science here. But when he ventures beyond the confines of his own discipline, he should expect to receive a different type of criticism than strictly technical issues invite–hence this essay.

Whether or not Tegmark's work constitutes a direct assault on the principle of specified complexity is a discussion for another time. The thing we have established beyond reasonable doubt is that in an article purporting to be about empirical science, Tegmark smuggled in more than a little scientism, a variety of philosophy currently favored by the editors of *Scientific American*. And to parade philosophy as science is never a good idea.