METAPHYSICAL PROBLEMS IMPLIED BY MODERN COSMOLOGY

by

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Introduction

More than most other sciences, cosmology has a metaphysical basis. This is because every cosmological conclusion has serious implications about the nature of reality. In other words, it implies certain things that lie beyond physics, and that is what the word "metaphysics" literally means: "That Which Lies Beyond Physics".

It has been widely touted in the recent past, especially by cosmologists like Stephen Hawking of Cambridge University, that the science of cosmology is near to solving *everything:* that is to say, it will be possible in the near future to know exactly why the universe exists, why we exist, and predict (at least theoretically) the probability of *every* event that can possibly occur. In other words, it is claimed that physics will encompass metaphysics itself: that there will no longer be any need for metaphysics as a separate discipline.

It seems to me that this is likely to remain a dream for a much longer time than is envisaged by Hawking and others—if not forever. I shall try here to give the reasons for my scepticism.

Problems with Mathematics

Some of the most serious problems science faces today—indeed, much more so than in the past—are connected with its most powerful tool, namely mathematics. And one of these problems has less to do with truth and untruth *per se,* than with the *perception* of truth or untruth.

These days in particular, in science—and especially in physics, which has more to do with mathematics than any other science—it seems to be assumed that if one uses mathematics in one's arguments, one has a greater likelihood of being right than if one does not. It's a bit like in the musical *Fiddler on the Roof,* in which the protagonist, Tevye, sings: "... And it won't make one bit of difference if I answer right or wrong; when you're rich they think you really know!" Well, in science, and especially in physics, it seems it doesn't make one bit of difference if you answer right or wrong: if you use enough math they think you really know!

And of all the branches of physics, this phenomenon is most pronounced in cosmology. This is because cosmology makes extensive use of what are called "models" of the universe. These are mathematical representations which try and describe the universe in terms of strictly determined rules. These rules are based on logic, and because of this, logic (especially in its symbolic form) is considered to be an aspect of mathematics. The reason cosmology can use so many different models is, that none of them can be actually tested against observation; so no model proposed by a mathematician, as long as it satisfies the rigorous demands of mathematics and logic, can be *dis*proved experimentally.

Now the "rigorous" aspects of mathematics and logic are not perfect, or at least, they are not rigorous enough for *everything* (which, after all, is what cosmology attempts to tackle). This has been elucidated, among other thinkers, by Gödel, who has shown logically that logic itself has limitations, and serious ones at that. And in this essay we shall show that there are several parts of mathematics which create great difficulties for cosmology.

Indeed it will be seen from what we shall have to say in this essay, that mathematics is a rather poor tool for *describing* reality—especially an *ultimate* reality. It is, of course, excellent—and even indispensable—for *transforming* what exists, or *predicting* such transformations when they occur in nature: but mathematics is, after all, an abstraction, or simplification—at times, indeed, an *over*simplification: and that is why it does not really describe reality itself.

To give an example from human life experience, the symbol *"$200"* is not the same as dinner for two at a fine restaurant, including drinks, tips and cabfare—even though two hundred dollars can, in fact, buy you just that.

Actually, words are also an abstraction, though somewhat less so than figures: the words *"dinner for two at a fine restaurant, including drinks, tips and cabfare"* are not exactly the same as the real thing, but they do come closer to describing the real thing than *"$200"*. This is demonstrated, for instance, by the fact that two hundred dollars can buy you other things quite different from dinner for two at a fine restaurant, including drinks, tips and cabfare; and if you've spent your money on those other things, you won't be able to have the dinner for two.

Models of the universe are somewhat like the term *"$200":* they are over-simplifications of the real thing. Of course, accountants as well as cosmologists make such over-simplifications all the time: they help us figure out the deductibles on our income tax, or the position of Halley's comet so many years from now. But they give us no idea of the real nitty-gritty of life: like how much actual *enjoyment* we get from the money we have in our bank accounts, or for that matter, what the *real* nature of the universe is.

Science Fiction

Indeed, one might say that models of the universe are more like science *fiction* than science. In science fiction, for instance, the author makes certain assumptions, and then constructs an imaginary universe that fits those assumptions, and their logical ramifications. For instance, in order to allow for the possibility of space travel faster than light, the author may assume the possibility of "bending" or "warping" space, the way one may bend a sheet of paper, to allow two points in that space to be brought much closer together, with the distance between them traversed using the "warp". (I guess that's what a "warp drive" is supposed to do!)

Nevertheless, as in *Star Trek,* this is a mere assumption, plus the logical ramifications of making such an assumption. If the assumption does not apply to *our* world, the theory may not stand up as far as *we* are concerned, whatever it may mean for the United Federation of Planets.

Now an example of such an unrealistic assumption made in science is in Einstein's Theory of Relativity. (It may sound somewhat sacrilegious to contradict Einstein, but in this essay we shall be doing so several times!) To develop the Theory of Relativity at least one over-simplifying assumption has been made, namely that the movements of all objects are time-reversible: in other words, that the equations of the Theory of Relativity are valid even if all objects in the universe move backwards instead of forwards. This is certainly true for the orbit of the earth around the sun, for instance: if the earth were to orbit the sun in the opposite direction to the way it's orbiting at present, it would keep on orbiting just fine. But the assumption is obviously *not* true of everyday human life: for example, an egg, once scrambled, will certainly not unscramble itself, nor will a cup, once broken, come together seamlessly, like in a movie run in reverse.

In fact it doesn't even apply in *space,* certainly not under *all* conditions. For instance, the exothermic transformation of hydrogen to helium—the process that makes stars shine—can only go one way in time: forwards. Stars do *not* shine if the movie is *really* run backwards: on the contrary, under such hypothetical conditions, light *enters* the star from all around it, and the star *absorbs* it all, turning helium back into hydrogen.

Also, since gravity is always attractive and never repulsive, things have a very disconcerting tendency to fall *into* black holes, never to fall *out of* them. If the movie were run backwards, black holes would be spewing stuff out into space at a horrendous rate, which would hardly reflect reality. So running a movie in reverse, however helpful it may be for entertaining children, is itself an over-simplification of reality. (We shall be discussing this "movie run in reverse" idea at greater length later, when discussing the "Big Bang").

Moreover, much of this phenomenon, according to science, is partly (but not entirely) due to the provisions of Second Law of Thermodynamics, which states that the disorder in a closed system must increase with time: that this increase in disorder, or chaos, is *not* time-reversible. Thus an egg cannot unscrambled itself and a teacup cannot put itself back together, because that would *increase* the amount of order. So in *some* respects the even Theory of Relativity, since it doesn't quite jive with the Second Law of Thermodynamics, must be an over-simplification of reality, though neither I nor anyone else can yet put the finger on exactly how. In that sense, then, even the Theory of Relativity is a little bit like science fiction!

In fact, Relativity is in greater trouble than even that, because it requires time to be treated just like any other spatial dimension. Now one can move backwards in space, but one can't in time. At least one would find oneself facing totally illogical conundrums if one could go backwards in time: such as the likelihood that one could change the recent past, by returning to an even remoter past and doing something that was never done then, such as murdering one's grandparents, and thus putting oneself out of existence, which would imply that one couldn't have murdered one's grandparents in the first place. So time really *cannot* be treated just like any other spatial dimension: which makes the Theory of Relativity at least quiver a little like jelly, if not entirely fall apart.

Come to that, if the Big Bang model of the universe is correct, then the Second Law of Thermodynamics must also be a bit like science fiction, because it implies that since the universe as described by the Big Bang model is a closed system, its disorder must also increase with time. This flatly contradicts the Big Bang model itself, according to which the universe *started out* in a complete state of chaos or disorder, with everything inside it moving about in all directions completely at random. At that time it had no eggs or teacups in it, or for that matter even stars or galaxies: and it has only now, after 15 or 20 billion years, come to the far more orderly state it is in today, in which stars, galaxies, eggs and teacups, and professors of physics too, have a very real existence—which would seem to indicate that order *increases* with time, at least on the largest scale.

To avoid this dilemma, many cosmologists have lately been invoking a quirk in the mathematics of present-day physics that allow for the embryonic universe—just a tiny fraction of a second after the "Big Bang"—to expand a great deal *faster* than the speed of light. This is called "inflation", and such a phenomenon allows for a lot of order to be created inside a totally disordered universe: the universe is supposed to expand so fast that light can't keep up with the expansion, and so pockets of light and darkness are created in what would otherwise have been a smooth sea of light. The light ultimately creates matter, the way gamma rays can spontaneously generate particles and anti-particles in "atom-smashers" on earth.

In this manner "information" is supposed to have been generated in a chaotic universe—or in other words, "inflation" is invoked to "wind up" the universe to a state of order. Thereby it has been mathematically "proved" that given an "inflationary" universe, one *could* have a universe which started out with a great deal of order in it; and that everything must be now "running down" into a state of chaos once again, but so slowly that it would take billions of years to get there.

Now this would seem to imply that at least during an inflationary phase, order *can* increase with time. So it doesn't get really rid of the problem, it merely confines the problem to a very specific time in the history of the universe (the scientists hoping, no doubt, that it's so short a time that no one will notice). Thus, even according to present-day physics, the Second Law of Thermodynamics doesn't apply at *all* times. In other words, it isn't a *truly* universal law, since it doesn't jive with at least one other theory used in physics to describe the universe! (Not to mention that the idea of “inflation” flatly contradicts Relativity as well, since according to Relativity, nothing can travel faster than light).

Mathematical “Proofs” Overthrown Many Times in the Past

Now the Theory of Relativity and the Second Law of Thermodynamics—as of course the “inflationary” Big Bang model—are all supported by “rigorous” mathematical proofs. But as we have seen above, both the first and the second of the three are in one or another respect unrealistic, and as for the third, it not only contradicts the two former, but is also extremely tenuous, so much so that we don’t even dignify it yet with the term “law” or “theory”. All of which just goes to prove that just because a theory is mathematically rigorous, it doesn’t necessarily “prove” anything. It just means that the initial assumptions used to develop the theory (or law, or model, or whatever) don’t fit *all* the facts.

In other words, all these laws, theories and models are a bit like the term *$200:* namely, oversimplifications of reality.

Another example of the unsatisfactory nature of mathematics for describing reality is Hawking’s own early work in cosmology. In 1970 he, along with Roger Penrose, “proved” mathematically, using (what else?) the equations of Relativity, that every body—and this includes you, me and Hawking himself, not to mention the stars, planets and asteroids—must some day end up as a singularity of infinitely small volume. Now this conclusion is so preposterous that if the authors had not used mathematics, no one would have taken them seriously; but since they used a lot of math, people thought they really knew. Later Hawking himself, after thinking about it for a while, felt that he was wrong; and since then has spent considerable time and effort trying to convince everyone of *that*. In addition—at least this is what I understand from his works—he has given up trying to be “rigorous” (in other words, using a lot of math), and instead has concentrated on trying to really *understand* the universe.

In fact a little reflection ought to show that this sort of thing has been happening a lot in science in the last two- to three-hundred years: at least since Newton wrote his *Principia Mathematica Philosophiae Naturalis,* or “Mathematical Principles of Natural Philosophy”. Innumerable scientific theories since then, including Newton’s own, have been rigorously “proved” mathematically, only to be found wanting some time later, by other theories which were also rigorously “proved” mathematically. This has happened so many times by now that one might expect scientists to take note of this pattern of events, and not expect too much of such “proof”!

Problems with Zero and Infinity

To my mind, the reason this has been happening is the fact that our understanding of mathematics is itself imperfect. Leaving aside for the moment Gödel’s Theorem, which “proves” mathematically and logically that both mathematics and logic have their limitations, we also have problems with our present understanding of the concepts of zero and infinity. And since these two terms keep cropping up in much of the mathematics that deals with cosmology, they screw up the calculations no end.

For instance, there seem to be (and perhaps *can* be) only two possibilities regarding the ultimate nature of time in the universe: that it had beginning (that is, started from zero), or it did not (that is, extends for an infinite period). Now as we shall see further on in this essay, neither of these two ideas can be treated entirely satisfactorily from a realistic viewpoint. No theory which is "proved" rigorously with these terms, either expressed or implied therein, is going to hold much water for long, and will likely be overthrown well before Christmas.

Even Hawking's theory of time, which tries to get around this difficulty by postulating that time is finite but has no beginning nor end, requires the existence of a couple of points at which time reverses direction: that is, that the "tangent", if one may so put it, to the time curve has to be zero at two points on the curve, namely when it reverses direction, from forwards to backwards, and backwards to forwards. (This is supposed to be more or less like what happens when you walk southwards all the way to the South Pole, and keep on going: you start going northwards once again—that is to say, you "reverse" direction, even though you did not turn around to do so. The tangents to the curvature of the earth at the north and south poles are parallel to the equator, so they have an angle of zero degrees compared to the equator; and thus their trigonometrical tangent is also zero.) Now this "zero tangent" problem brings in the notion of the mathematical zero, a very tricky one indeed, as we shall see in greater detail further on in this essay.

Problems with the Big Bang

In fact it has been realised for quite some time now that the "Big Bang" model of the origin of the universe has several problems, some of them perhaps impossible to overcome. One of them is, that if the all the mass of the universe was all in one location at the instant of the "Big Bang", what was there to prevent the enormous gravitational force generated by this mass from pulling everything back down to nothing at the very moment it became something, or just a little later? Black holes—or so physics tells us—become black for exactly this reason: absolutely *nothing* can escape their pull, not even light, which can escape from the pull of everything else.

At the moment the "Bang" banged, or even a split-second later, the gravitational pull of the entire universe, concentrated in a space smaller than a watermelon, would have been so enormously greater than that of any black hole ever postulated, that no known force could have come even close to overcoming it. It also makes little sense to postulate a hypothetical force that could do so: for, if such an "anti-gravity" force is actually possible, where is it, and why doesn't it overcome the gravitational attraction of black holes?

One solution to this problem has been, in the recent past, again to postulate the "inflationary" phase. It appears that inflation faster than the speed of light can allow for the initial mass of the universe to be low enough so that it doesn't contract due to gravity at the moment of "conception": the additional mass can be added later, during the inflationary phase. But if additional mass can be added to the universe at any time, it could be added even now. Why isn't it being so added? This is a problem with an inflationary universe which doesn't seem to have been tackled as yet.

Actually even "inflation" doesn't seem to take care of all the gravitational problems of the early universe, because the inflationary model still insists that the universe was no larger than a grapefruit (approximately) when all the creation of all matter in it was complete. This is hardly large enough to counter the gravitational attraction of all the mass of the universe: at that size it ought to have collapsed into a black hole anyway, in spite of the "inflation".

"Expanding" Space

Another problem of the Big Bang model is the notion, widely mentioned in all the literature, that it is not the stars and the galaxies and other objects in the universe that are getting farther and farther apart, but that space itself is "expanding". Now to a thinking person the question immediately arises: "expanding" compared to *what?* Distances in space are measured with the help of comparisons. Objects, such as (in ancient times) human arms, or (in more recent times) standard rulers or tape measures, are assumed to be "non-expanding" and are compared against the space between any two other objects. (And to make sure that all rulers and tape measures in the world agree with each other, they are, in the final analysis, compared with a special metal rod with marks on it exactly one metre apart, kept with great care in Paris). If space itself is expanding, then so must the objects in it be; and if so, how could one ever tell whether space is truly expanding or not? It's a circular argument: if all of space is expanding, then so are all the rulers and tape measures in the world, and even the rod in Paris; and if that's the case, we, by using a "stretchy" ruler, tape measure, or rod to measure anything, wouldn't be able to meaningfully determine whether the expansion of space was real or not—now would we? It would be like measuring a table made of marshmallow with the help of an elastic tape measure: one could get any result one wanted!

Even in the most recent times, when the metre has been re-defined as the distance light travels in a certain fraction of a second, we still have the same problem; for we must still measure that distance with some object. And besides, time itself is measured with the help of (other kinds of) material objects, like pendulums or cesium atoms, which according to the theory would also be expanding (and thus giving "expanded" readings of time). All of which seems to leave the whole argument just as circular as it ever was.

There are other problems with "expanding" space as well. For instance, the universe is considered to be about 20 billion years old, the solar system about 5 billion years old, and the universe is regarded as expanding at a steady rate (these seem to be what most cosmologists have agreed upon). The earth is at present 150 million kilometres away from the sun. If the space between the earth and the sun has been stretching at a steady rate, then, the earth must have been a lot closer to the sun at the beginning of the "life" of the solar system than it is now: about 120 million km away (or about three quarters of the distance it is now). But the masses of the earth and the sun must have been pretty much the same as now, and the speed of revolution of the earth around the sun can't have been much different either! Then what would have prevented the earth from crashing into the sun, due to the much stronger gravitational attraction the sun would have had (according to the inverse square law, [16÷9] times, or almost twice as much as it is now)?

Why, at that time the Andromeda Galaxy would also have been much closer to our own Milky Way—instead of 2 million light years away, only about 1.5 million. And earlier still, say 12 billion years ago, the two galaxies would have been so close, they would have had a very strong gravitational attraction on each other: so strong, in fact, that it would have been hard to separate them. Then why are they separate now?

And it gets more complicated still. The earth is now about 12,000 kilometres in radius, which means that its atoms are, at their farthest, about 12,000 km away from each other. If space itself has been expanding for the last 15-20 billion years, then 5 billion years ago the earth must have had about 3/4 the diameter it has now: 9,000 km or thereabouts. This means its volume then would have been less than half (33/43, or 27/64) its present volume. But it would have contained approximately the same number of atoms as it does now (why wouldn't it?). So how was it possible to squeeze together so many atoms in so small a space?

You may say, the atoms were smaller too. This does not get rid of the problem, though, because then Quantum Mechanics steps in, with Plank's constant. Quantum Mechanics requires that the product of the uncertainty of an electron's momentum and the uncertainty of its position must always be greater than a particular constant figure, whose value is Plank's constant divided by 2π. If the electrons in an atom are squeezed into a smaller space—that is to say, if their position is more restricted—then they have to have greater momentum, to make up for the more restricted position; and the greater momentum causes them to burst out of the smaller space: in other words, causes the atom to "expand" once again. So there's no way to squeeze atoms into dimensions smaller than they have at present, except if you change Plank's constant, and that ain't so easy to change, because ... well, because it happens to be constant!

Problems with Multiple Dimensions

Yet another problem with the "Big Bang" is that in some of its models, the universe is not closed but open. (An example of a closed surface, in two dimensions, is the surface of a sphere, while an example of an open two-dimensional surface is the surface of a saddle). Now the if the universe is open, it implies that there is an "edge", some place where the "saddle" comes to an "end". (A closed surface like a sphere does not need an edge or an "end", but any open surface—saddle, sheet of paper, or whatever ... even a Möbius strip—has "edges" where the surface itself comes to an end). Even if the saddle is expanding, and the edge with it, there would still be the necessity, *somewhere,* to have a "drop-off point" where the universe comes to an end (in this day and age, what with all the lawsuits, there probably are signs posted at regular intervals: *"The Universe Ends Here: Proceed At Your Own Risk").* So the question arises, "What lies beyond the edge?"

Some astrophysicists say this is a meaningless question, like the other question "What was there before Time began: which is to say, before the Big Bang?" But some consideration will show that it's not really all that meaningless. All models of the universe—due to the general acceptance of the Theory of Relativity—use non-Euclidean geometry to describe space and time, or space-time as it is more accurately termed. Examples of two-dimensional non-Euclidean geometry are the ones mentioned above, namely that of the surface of a sphere, or of a saddle. On the surface of a sphere or a saddle, the shortest distance between any two points is not a "straight" line (as we know straight to be), but a curved line. In the case of a sphere, this line is a portion of a "great circle", that is to say, a circle with its centre and radius identical to that of the sphere. This line is, of course, "curved" from an Euclidean point of view, but is the straightest possible line on the surface of the sphere, to which it is restricted by definition.

There are also other peculiarities of a curved two-dimensional surface, such as the fact that the sum of the angles of a "triangle" do *not* add up to 180 degrees, and that lines that start off "parallel" to each other do not stay the same distance apart when extended indefinitely in either direction. (Of course these "triangles" and "parallel lines" are not straight, by definition—which begs the questions, "What sort of triangle is made up of curved lines?" and "In what sense, exactly, are such curved lines parallel?"; but let's leave those problems aside for now.)

Now it will be obvious that in order to postulate the existence of a curved two dimensional surface like that of a sphere, one has to assume a *three* dimensional space in which that two-dimensional curved surface can exist: one can't have a curved plane in only two (Euclidean) dimensions. In fact this sort of requirement is true of *all* non-Euclidean geometries. A *straight* line, for instance, has (by definition) only one dimension, but in order to postulate a *curved* line one needs to assume a surface having at least two (Euclidean) dimensions, in which the curved line can exist. (There can also be more than two, of course: a curved line can exist in three dimensions too). On the other hand, to have a *straight* line in the Euclidean sense, one does *not* need a two-dimensional plane: it can exist just fine in only *one* dimension. Similarly, one can have a flat plane in only two dimensions, but to have a plane that is the least bit curved, one needs to assume the existence of at least three (Euclidean) dimensions.

In other words, to postulate a curved non-Euclidean "space" of x dimensions, one needs to assume the existence of a Euclidean space of at least $(x + 1)$ dimensions. So in order to postulate a curved *four*-dimensional non-Euclidean "space-time" such as that required by Relativity, one needs to assume at least a *five*-dimensional "Euclidean" space in which it can exist. (The reason the word "Euclidean" is in quotes here is that Euclid himself never thought of more than three dimensions. However, it *is* possible to have a two dimensional Euclidean space—that is, a space with one dimension less than three—so as far as I can see at present, there is no logical reason why there couldn't be a Euclidean space with four dimensions as well. And if there are four, there could, equally logically, be five, six or more dimensions too.)

Therefore, going back to the analogy of the "saddle": if the saddle-shaped four-dimensional space-time, which is required by some "Big Bang" models of the universe, comes to an end somewhere, that "somewhere" would have to be in a *fifth* (Euclidean) dimension.

Since we are all familiar with Euclidean dimensions from everyday living, we would, therefore, recognise it when we see it, and we *would* see it at the end of the universe. So maybe (as I once read in a science fiction story) there's also a wall at the end of the universe, to keep people from falling over the edge, and a hole in the wall with a cover over it, and a slot where you can insert your coin; and when you insert your coin the cover comes off, and you can look through the hole and see for yourself that there is nothing beyond.

There are additional problems with a finite universe as well, which we shall discuss later on in this essay.

Serious Problems with an Infinite Universe

However, although a finite universe may have its problems, an infinite universe has its problems too: perhaps more so. But they are not the problems described in most text books: as we shall prove below, most of the common arguments against an infinite universe found in modern books on cosmology don't hold water.

For example—and this question has been asked numerous times in the literature—why is the sky dark at night? It sounds like a stupid question, but a little thought is needed to pose it (with emphasis on the word *"little"*). The argument goes as follows: if the stars extend for an infinite distance, there should be an infinite number of stars in the universe. So *every* line of sight would have to end up, *some*where, on the surface of a star. In that case, the entire night sky should be as bright as the surface of the average star, namely much like the surface of the sun. It obviously isn't. So, *if* an infinite universe is filled with stars (which, however, definitely wouldn't be the case, as we shall see further on) it seems very hard to "rigorously" postulate a universe of infinite size.

People have enunciated other problems regarding an infinite universe as well: for instance—as Newton himself mentions in his book—it seems impossible to have gravity as we know it. Every object would be surrounded by an infinite number of other objects, all of them pulling with infinite force in every direction. This is because even though they might all be very far away, there would be an infinite number of them. This would end up with the pull of every object being cancelled out by the gravitational attraction of the objects on the opposite side. The net effect would be zero gravity everywhere. Thus Hawking says "It is impossible to have an infinite static model of the universe in which gravity is always attractive" (*A Brief History of Time,* page 5).

However, neither of these arguments really stands up to the closest kind of scrutiny, because they both assume that an infinite universe is pretty much the same everywhere, namely much like it is around here (within a thirteen- to fifteen-billion light-years' distance, of course—but that's a piddling distance compared with infinity). However, as we shall prove below, this is definitely not going to be the case: mathematics and logic *demand* that an infinite universe, if it really *is* infinite, has got to be filled with the most incredible marvels, the likes of which we have never seen, and indeed could hardly even begin to imagine.

Postulating an infinite universe *does* have problems, but they are much worse than the ones argued above. Taking the notion of infinity seriously is, in point of fact, enough to drive a finite human mind stark raving mad. It's true that we often use the term glibly; and some eminent scientists, like Alex Lerner and even Nobel Laureate Hannes Alfvén, have gone so far as to postulate that the universe is actually infinite—obviously without trying to grasp how big infinity really is. But when meditated upon seriously, the notion of infinity is worthy of at least a Kafka novel.

Exercise to Try and Grasp the Immensity of Infinity

Do the following as an exercise: write down the biggest finite number you can think of—like, say, a Googolplex (as you probably know, 10^100—which is about the number of electrons in the visible universe, give or take a few orders of magnitude—is defined in mathematics as a Googol, and 10 raised to the power of a Googol is defined as a Googolplex). Now raise a Googolplex to the power of a Googolplex raised to the power of a Googolplex raised to the power of a Googolplex ... and do this a Googolplex times over, and then triple it for good measure, and add eleventeen. Then sit down and smugly think about how absolutely *h u m o n g o u s* this number is in comparison with anything you have ever known.

But now compare this number with infinity. As you can plainly see, it is as *nothing,* or pretty darn close to nothing, when compared to infinity. (The reason I say "pretty darn close" is that a *real* nothing is infinitely *smaller* than any finite number, however small; but we shall leave off discussing the peculiarities of nothing-at-all till later).

Now this exercise may sound like an over-sensationalisation using mathematics for an excuse, but as we shall see below, it has quite definite logical and mathematical implications. For instance, it is mathematically certain that in an infinite universe, *everything* that is even remotely possible, even though highly improbable, *must* exist.

The Peculiarities of Probability in an Infinite Universe

This is because of the way probability is treated mathematically. A tossed coin, for instance, has a chance of 1 in 2 of landing heads up. But if you toss two coins, or toss one coin twice, it has 3 chances in 4 of landing heads up at least once. This is obviously better than 1 chance in 2. If you toss it three times, the chances of it landing heads up at least once become 7 in 8, which is better than 3 in 4. The more times you toss the coin, or the more coins you toss, the chances of at least one landing heads up keep on improving. So if you toss a million coins, or toss a single coin a million times, it is virtually certain that at least one will land heads up. And if you toss an infinite number of coins or toss a single coin an infinite number of times, it is *absolutely* certain that at least one of them will land heads up.

The same goes for any kind of event, whatever its probability of occurring. Take the throw of dice. If you throw a die once, there is only 1 chance in 6 that it will land with the six dots up. But if you toss an infinite number of dice, or toss a single die an infinite number of times, it becomes absolutely certain that at least one will land with the six dots up.

So think of *any event at all,* and take a wild guess as to what chance it has of occurring. One in a million? One in a billion? One in a trillion? One in a gazillion? No matter how big that number is, as long as it is a finite number, it's still virtually as nothing compared to infinity. *Every* finite number goes into infinity innumerable times—an infinite number of times. So unless an event has absolutely *no* chance at all of occurring, given an infinite number of chances, it *must* occur, with absolute mathematical certainty.

Now in an infinite universe there can be no limit to the number of objects: for (among other arguments) to postulate an infinite stretch of space without objects to fill it would appear to be meaningless. (Nevertheless we shall be discussing this peculiarity too, later on). It also follows from what we have said above, that in an infinite universe there can be no limit to the total number of *each kind* of object. There can be no limit to the number of coins, to the number of dice, and so on. This is because every object is simply a collection of a finite number of elementary particles—baryons, leptons, mesons, quarks, photons, gravitons, super-strings, "wavicles", or whatever the latest particle-physics theory allows. And thus there is always going to be a finite probability that a finite number of elementary particles, *whatever they may be,* have come together precisely in such a way as to form a particular object of finite size: a coin, a die, a Porsche 911 or anything else.

And since there is a finite probability that there is, for example, at least *one* coin in an infinite universe, there is also a finite probability—somewhat smaller, naturally—that there are two; and also a finite probability—even smaller of course, but still not zero—that there are three, four, five ... or for that matter any number you can think of, plus one. So no matter how many coins you wish to postulate there can be in an infinite universe, there must be at least one more. Thus there can be no limit to the number of coins in an infinite universe. And the same applies to dice, eggs, teacups, Porsche cars, professors of physics, or anything else.

Now this conclusion allows for a staggering variety of objects in the universe: for different objects can come together in different ways to make other, larger objects—the way nuts and bolts and wheels and tires and engine and chassis and transmission and dashboard and wipers and windshield and other such objects can come together to make a Porsche. And this, obviously, can happen in ways hitherto unimagined, because any number of smaller objects, *whatever they may be,* can come together in such as way as to make up an object bigger than any of them. As a result this proves, mathematically speaking, that there can also be no limit to the *variety* of objects in an infinite universe, and no limit to their *size* either.

Copies of our own "Universe"

Thus it is not merely likely, but a definite mathematical certainty, that if the universe is really infinite, *somewhere* in that immense vastness a great many elementary particles have come together, purely by accident, in such a way as to duplicate the place we call "our known universe" in every single detail, including you, me, our families (if we have any), our pets (if we have any), our Porsches (if we have any), the mechanics in the garages and the professors in the universities, the rattlers in the prairies and the orang-utans in the jungles, the stars in the galaxies and the quasars far far away from the home planet, not to mention New York. This is extraordinarily improbable, but no presently known law of nature precludes such a thing from happening—and the proof is, that it actually *has* happened here!—so in an infinite universe, it *must* have happened somewhere else too. This is a mind-boggling conclusion, but it is totally logical and mathematically impeccable. If the universe truly *is* infinite, all those people and animals and things must definitely be out there somewhere, going about their business, blissfully unaware that *we* exist, an exact copy of everything they know. Most of them, indeed, wouldn't even believe in *us,* just as most of us wouldn't believe in *them.*

And if you think that's bad enough, let me tell you, it can get a lot worse: logically speaking, in that immense vastness there must be an even further copy of the place we call "home", along with every single one of its professors and Porsches and stars and galaxies and quasars and New York and all, exactly like ours except for one small detail, namely that Hitler won the Second World War!

Sherlock Holmes's Principle

Thus everything that is merely "highly improbable" (and which we often wrongly speak of as being "impossible") *must* exist in an infinite universe. For instance, improbable as it sounds, somewhere in the vastness of infinity there must, *quite literally,* be a very puzzled person sitting at a table tossing a coin for an entire lifetime, and seeing it land heads up every single toss. There must also be, somewhere in an infinite universe, that proverbial horde of monkeys sitting at typewriters and typing away at random, producing the entire works of Shakespeare totally by chance. This too is highly improbable but not totally impossible, so in an infinite universe it can no longer be proverbial, but must be a dead cert!

Why, it is also certain that somewhere in that vast infinity there is a place very much like our own, in which there is a *real* Beverly Hills Cop named Axel Foley, who bears a striking resemblance to our own Eddie Murphy, and who is at this very moment attempting, with the help of other cops improbably called Tagart, Rosewood and Bogomil, to track down a murderer and drug dealer called Victor Maitland in another Beverly Hills in another California on another Earth in another Milky Way, far, far away from us. Come to that, every movie ever made and every play and novel ever written, whether based on fact or fiction, *whether produced in our "known universe" or in another*—provided it is not totally impossible to duplicate in reality—*must* be duplicated in reality somewhere in a total universe that is *really* infinite. As Sherlock Holmes said, "Once you have eliminated the impossible, whatever remains, however improbable, must be the truth."

Indeed, in an infinite universe, even Sherlock Holmes, along with Hamlet, Macbeth and Don Quixote, must have a too, too solid and fleshy existence. *("To be or not to be*, that ain't the question—it's always gonna have to be *To Be!")* And yes, Virginia, in an infinite universe there really *is* a Santa Claus.

Science Fiction as Science Fact

And it gets weirder and weirder the more one takes it seriously (which is a weird phenomenon in itself). For instance, due to the two facts that an infinite universe must contain an infinite variety of objects, and that in an infinite universe every thing that *can* exist *must* exist, every invention ever made—and also every invention that ever *will be* made—must exist in an infinite universe. So somewhere out there, if you search hard enough, you should be able to find your standard issue photon torpedoes, laser phasers, holodecks and even entire Federation Starships—and pretty much every other device dreamed up by every sci-fi author since the Prophet Ezekiel, as long as it has the least chance of being a viable invention.

Indeed, every alien life form that could possibly exist, however remote that possibility may be, must also exist somewhere in an infinite universe. So somewhere in outer space, what to speak of Romulan cloaking devices, even the Romulans themselves, along with E.T., Mr Spock and Darth Vader, must have a very real existence. Why, some of them, like Yoda the Jedi Master, have got to be considerably smarter and wiser than we are (although it surely wouldn't be too hard to achieve *that* goal, considering the various messes we've gotten ourselves into from time to time).

And an infinite universe also implies an eternal universe, for more than one reason: for example, if eternity is not implied, the objects in the universe could never have had enough time to distribute themselves over all of infinite space. Also, if one claims that the universe is infinite in space but limited in time, what one is really saying is, that one fine morning in the middle of nothing an infinite universe came into being everywhere all of a sudden, and one fine evening it's going to disappear just as suddenly as it came—which really is a bit too hard to swallow. (But then again, why not?)

Anyway, if the universe is eternal in time as well as infinite in space, many of these super-smart aliens (of whom we spoke earlier) must have had quite enough time to grow even smarter and more technologically advanced, and thus to develop “warp drives” or even faster modes of transportation; and to use that technology to travel as far as our own neighbourhood of the universe—maybe all they have to do is “beam” themselves over here in the twinkling of an eye, or whatever they use for eyes. So they may have even got to know us, or at least have watched our TV programs which we’ve been broadcasting all over space ever since we invented TV, and which have by now spread to a distance of 50 or 60 light years from earth. (Not that Yoda looks too much like he watches soaps, except maybe occasionally). The very fact that we ourselves exist at all, probably indicates that based on their viewing, they don’t consider us to be too much of a threat to them. Now *that’s* a humbling thought.

The Implications of Intelligence and Consciousness

Indeed if one seriously postulates an eternity of time as well as an infinity of space—and it’s really hard to see, from our present understanding of science, how the one can exist without the other, since Relativity too requires time and space to be inseparably linked—then even more wild and wonderful things become inevitable. This is due to the fact that the universe also contains two very significant—and, in the long run, immeasurably powerful—forces, viz., intelligence and consciousness: namely our own. Agreed, we have very little of the former yet, but we’re getting better; and we do have a lot of the latter. And one of the by-products of intelligence and consciousness seems to be technological skill, or the ability to manipulate one’s environment to one’s own benefit.

Now as we have shown, if *we* have these properties, it is inevitable that others have them too, somewhere in that immensity. Indeed due to the immensity of infinity, there can be no end to the number of intelligent, conscious and technologically skilled life forms out there. And therefore, at least a fraction of that number must have developed technology so advanced, that to us it would appear quite magical (as Arthur C. Clarke has convincingly stated, “Any sufficiently advanced technology is indistinguishable from magic”). Out of an infinite number, however, “a fraction” is also an infinite number: and thus there can be no end to these highly skilled technicians in an infinite universe.

Now it is one of the characteristics of both intelligence and consciousness, that they increase with time: at least, that’s what evolution on earth seems to indicate, with a zillion and one examples, and more. Indeed they seem to increase at an increasing *rate,* almost in geometric progression. So if there’s enough time—an *eternity* of time—then once these properties appeared anywhere, they would tend to increase, and that too increase at an increasing rate, indefinitely. Of course in some such cases the destructive tendencies of the aliens in question would destroy them before they managed to get *really* smart and figure out that they’re being self-destructive—as we ourselves might be doing.

But since there would be no end to the number of such life forms, at least *some* of them must, inevitably, wise up to that danger, clean up their act, and stop themselves before it's too late. (As Buckminster Fuller has said, "Right now, humanity is sitting for its final exam"). After passing such a final exam, intelligent life forms would just keep getting more and more intelligent, and that too at a faster and faster rate, till they became *infinitely* intelligent! (Hey: they'd have had all of eternity to get there).

And even if the term "infinitely intelligent" has no real meaning, at least to our finite human minds, there would be nothing to prevent such aliens from developing, over an eternity of time, technology capable of getting round many, or even all, the limitations of the universe they live in, along with its infinities, zeroes, speed of light, Planck's constant, Heisenberg's uncertainty principle, and whatever else they may find cramping their style. In other words, they are probably able—given an actual eternity of time—to substantially modify their universe to make it more suitable to their own way of life, after the manner in which we ourselves modify our environment (limited at present to objects on a more or less human scale, and mostly confined to the earth, and at best a few thousand miles out in space).

Thus, on the principle that "anything we can do, they can do better", they could, in all likelihood, *create* new universes which would be more to their liking than the one they were born into: just as we nowadays create cities which we like better than the jungle, are thinking in the future of "terraforming" other planets like Mars, and even, in a more distant future, of manufacturing "Dyson spheres" all around an entire star, so as to capture *all* of its energy output for human use.

And on the principle that "anything they *could* do, they *would* do" (don't we ourselves follow that principle?—and doesn't every other creature we know?) if they *could* modify the present universe or create another one, they most likely *would.* And that raises the distinct possibility that we are actually living inside an entire universe modified or created by one of these incredibly super-intelligent life forms to suit themselves (just as our tigers and lions are living in a terrestrial environment increasingly being modified to suit *homo sapiens.*) Such a universe probably suits those aliens just fine, but since it wasn't tailor-made for *us,* we of course don't like it all that much. But they probably don't care, unless they happen to regard us as a "protected species".

And be it noted very carefully, that even though the words "maybe", "probably" and "probability" occur several times in the argument above, we have already demonstrated that anything that is at all probable becomes an absolute certainty in an infinite universe. *So everything we have said above has GOT to be so!*

The Impossible Implications of Absurdity

If all this sounds absurd, that's because it's meant to be. It's also meant to be taken seriously, however. It's what is called a *reductio ad absurdum*, that is to say, illustrations of the absurd implications of a theory, hypothesis or postulate. If the logical implications of such a notion are absurd, then so also must the notion be, at least in some respect.

And (eyebrows raised!) it gets even more absurd. All this time we've been discussing mere improbabilities, not true impossibilities, such as the "fact" (required by Relativity, and apparently indicated by many "experiments") that the speed of light is a constant for all observers, and cannot be exceeded. But the logical implications of an infinite universe extend far beyond mere improbabilities. For one thing, an infinite universe implies, quite literally, that we can never know it all, or even get any kind of signal from all of it, whether we or the signals travel at light speed, or even at warp speed. Mathematically, if we postulate any finite speed at all, no matter how great, as being the speed limit in an infinite universe, we—and even those super-smart aliens—would still have to remain ignorant of most of it. Only at truly infinite speed could we, or any signal, travel the length and breadth of a truly infinite universe: and infinite speed implies all sorts of other weird and wonderful impossibilities, such as being in two places at the same time, or even, for that matter, being everywhere at once.

Actually, due to the limitations of Quantum Mechanics, this problem applies to finite universes too, provided they are large enough (such as those postulated by some "inflationary universe" theorists). Quantum Mechanics implies that there must be a theoretical limit to the size of any observable universe: this size would be the distance it takes for light from the brightest object that could possibly exist to spread out so much, and thus become so faint, that it reaches the observer in a quantity less than one photon (a photon being the quantum of light). It is an immutable tenet of Quantum Theory, that less than one quantum of anything cannot be detected, even with the most perfect of (theoretical) instruments; and if that's the case, even the brightest possible object couldn't be observed beyond a certain (finite) distance.

And there *must* be a limit to how bright an object can get, at least as far as an outside observer is concerned: for instance, if the quantity of light produced by an object is so great that the gravity generated by the mass of that light itself is enough to trap all the light into a black hole, then no matter how much brighter the object becomes, none of its light could ever leave it, and thus the object could never be observed. (Other arguments like this could also be devised, and the reader may find it illuminating to meditate upon the subject independently).

So in an infinite universe—or even in a large enough finite universe—our part of it must perforce be surrounded by an immeasurably larger unknowable part (”immeasurable" because there would, of course, be no way to measure it.)

And in an infinite universe, this would actually be an *infinitely* larger unknowable part. In fact, not only could we not know all of an infinite universe, we couldn't even know a significant part of it: we could only know an *in*significant part, literally and mathematically speaking, of an infinite universe.

Now if we can know only an insignificant part of the real universe, it follows logically that nothing we can possibly say about the whole universe has any real significance. And this opens up the possibility, not only of having improbabilities as certainties, but of having true impossibilities as real possibilities. This is because there would be absolutely no guarantee that *anything* we say about the entire universe is true: how could we possibly know? At the very least, nothing we say about the entire universe could possibly be meaningful (for that's what "significant" means). A meaningless statement can't, of course, be true, at least logically speaking, no matter what Alice or the Red Queen might have said about it.

Thus we would never be able to truthfully say about *any* event *x*, that it has absolutely zero probability of occurring, all throughout an infinite universe. As a result, *every* event could have a finite probability of occurring—even those that are impossible!

In fact, we could never even say that mathematics and logic as we know them—what to speak of physics, chemistry, biology or history—must apply *all* over an infinite universe. That would be tantamount to claiming that we can know anything about something about which we can know nothing: an absurdly self-contradictory claim.

Actually this is not as far-out a claim as may be imagined, for as is well known to cosmologists, to a very limited and non-absurd extent this applies to finite universes too: such as at the centre of a black hole. However, in a finite universe such "singularities", as cosmologists call these localities where the laws of science don't apply, are infinitely small, and thus severely restricted.

The laws of *science* do not, of course, apply in a singularity; but it is not entirely clear, even to cosmologists, whether or not most of *mathematics* could apply there, since a singularity is supposed to be as small as a single geometric point. For this reason it is clear that geometry, at least, couldn't apply: how could a triangle or a square—or even a line—exist in an infinitely small space? And it seems logical, also, to think that a *finite* but plural number of geometric points—two or more—could not exist inside an infinitely small space: that is to say, a space big enough to contain only one geometric point. If they couldn't, then arithmetic too could not apply inside a singularity, since the number "two" couldn't even exist—there could never be any "two" of anything!

Anyway, arithmetic as we know it—that is, the arithmetic of limitless numbers—definitely couldn't apply in a singularity: if at all, only the arithmetic of *finite* numbers could apply, and even that is doubtful. And since arithmetic is the basis of all mathematics, most of the rest of math couldn't apply either.

And as Bertrand Russell and Alfred North Whitehead have "rigorously" demonstrated in their magnum opus *Principia Mathematica,* logic itself (at least in its symbolic form, namely logic written in a kind of shorthand) is, from a larger perspective, just an aspect of mathematics. So logic as we know it couldn't apply inside a singularity either.

But as we have seen above, in an infinitely large universe, singularities can also be infinitely big. Therefore, somewhere in those infinitely huge singularities there could well be extensive zones where two plus two never make four, and triangles have six-and-a-half sides. Or localities where the speed of light is neither constant nor a universal limit. Or regions where eggs always spontaneously unscramble themselves, and broken teacups repair themselves without any glue. Or spaces where gravity is repellent and light is dark—thus causing our night sky to be black, and our gravity to be (locally) attractive.

This means, indeed, that there could be, in an infinite universe, enormous stretches of time and space where none of the laws of science and the principles of mathematics as we humans know them—or, for that matter, even the principles of Vulcan logic—can apply at all!

So it shouldn't come as a total surprise to find, somewhere out there in the infinite vastness, a lamp which, when rubbed, sends forth a genial Genie sounding very much like our own Robin Williams, offering to fulfil any three of your wishes, and singing: "You Never Had A Friend Like Me".

What? *Any* three wishes? No provisos, no *quid pro quo's?* Well, as we have demonstrated from the above, in an infinite universe, anything that *can* exist *must* exist, while if anything *can't* exist, it *may* exist. But since it *may* exist—which is to say, has a likelihood of existing—it means, once again, that it *must* exist! "Mr Aladdin, Sir, what will your pleasure be? Let me take your order, jot it down ... if it is possible it is done, while if it is impossible it *shall be* done!"

So if there is the least likelihood of a Genie—or for that matter, even God Almighty—existing: or, as we have seen, *even if there is **no** such likelihood!*—then both the Genie of the Lamp and the Good Lord Himself have *got* to have an existence in an infinite universe! (This might be taken as a kind of mathematical "proof" of the existence of God, though not a very good proof I'm afraid, because one first needs to prove that the universe itself is infinite, and that doesn't seem to be all that easy to do).

Actually, according to our argument above, if the universe really *is* infinite, even to *say* that the universe is infinite—that is, to tell the exact truth—becomes meaningless. Thus we've just had the pleasure of proving logically, that everything we have proved logically above must be meaningless—which is as absurd a conclusion as ever I heard.

Not, mind you, that this argument demonstrates that the universe is *not,* in point of fact, infinite. It simply demonstrates that *if* it is infinite, our *saying* so has no meaning, and thus our statement can't be true. On the other hand, of course, if the universe *isn't* actually infinite, our saying that it *is* infinite would *definitely* not be true. So one way or another, we can never truthfully say that the universe is infinite, even if it actually is so!

Once you start thinking like this—as the nineteenth century mathematician Georg Cantor did—it is but a short step to the loony bin ... where Cantor himself ended up. So it is not surprising that most astrophysicists and cosmologists—whose business it is to at least try and think big—are shying away from thinking about the universe as being *that* big.

But it can get even bigger than that (if anything bigger could be imagined!) That's because if a real infinity is anything like the theoretical infinities of which we have some limited understanding in this finite world, then even bigger things are implied.

For instance, a finite line in geometry, no matter how short, is regarded as having an infinite number of points along it. (Finally, a kind of infinity we can think about without going bonkers!) Now any line can be divided into two; and each of those two lines must also have an infinite number of points along it. Moreover, each of the two lines can also be divided into two; and each of those two into two, too ... again and again, *ad infinitum.* So an infinite number of lines can be produced from any single finite line, each of those infinite number of lines having an infinite number of points along it. (One doesn't actually have to *cut up* and *separate* the lines; one may say, instead, that any single finite line can *contain* an infinite number of smaller lines, and each of those smaller lines contains an infinite number of points).

And an *infinitely* long line can always be cut up into two lines, each infinitely long; and each of those can be cut up into two infinitely long lines, and so on and on.

And of course, what applies to one-dimensional lines also applies to two-dimensional surfaces, three-dimensional volumes, four-dimensional space-times, five-dimensional whatchamacallums, and so on. All this is standard undergraduate math, confirmed by any relevant text book on the subject.

But now here comes the weird part: if a really infinite universe is anything at all like this, then not only must it contain an infinite number of *finite* universes, it must also contain an infinite number of *infinite* universes! And each of those must contain an infinite number of infinite universes, each of which would also contain an infinite number of infinite universes ... on and on, *ad infinitum:* a "ladder" of infinities without beginning or end, "top" or "bottom". Which means that *our* infinite universe must be on one of the intermediate rungs, so to speak, of the infinitely long "ladder" of infinite universes, and that there would have to be an infinite number of infinite universes infinitely larger than our own ... and also an infinite number of infinite universes infinitely *smaller* than our own! If that doesn't boggle the mind I'd like to know what does. (I mean, we're talkin' *reality* here, dude, not some abstract mathematical concept).

And Now For Something Completely Different: The Ultimate Nothing

As we have seen above, it's well nigh impossible to seriously postulate an infinite universe and come away smiling, at least not if you claim to be reasonable (i.e., following the dictates of reason). But as we shall see below, to seriously postulate a *finite* universe is no less fraught with self-contradictions! This is because every model of a finite universe contains within it the germ of the concept of an absolute zero, or nothing-ness.

The notion of zero, or nothing—and its logical implications—are quite as weird as those of infinity, if not more: it's just that very few people (outside of ancient India) have taken them seriously either, probably because it also tends to drive one crazy. It might be remembered that the concept of zero was first propounded in India, around the time of the rise of Buddhism, or perhaps a little before; and when it was first propounded there, it made quite a stir, because many Indians have, by nature, a philosophical bent of mind, and a powerful imagination to boot.

So if one reads Mahayana Buddhist texts—such as the *Sutra* entitled *Vajra-Chhedika* or "The Diamond-Shredder"—which discuss the nature of *Shunyata* (as "zero-ness" is called in Sanskrit), one begins to get an idea of just how far the notion can be taken. According to this text, a real nothing is much more than a mind-numbing a concept: it's hard enough and sharp enough, as the title of the text implies, to shred even diamonds! Once one starts thinking deeply about it, it becomes very appropriate, in more senses than one, to pay a visit to the shrink.

For instance, as the *Diamond-Shredder* implies, if you consider zero, not as a relative concept, that is to say as merely being applied to something particular (like zero bananas, or zero rupees), but as an absolute concept, that is to say as being applied to everything (like the notion of nothing at all), then logically speaking you have to end up with an emptiness that is *empty even of emptiness,* and which thus could, again logically speaking, be full of anything and everything: even thirty-three thousand wrathful deities, what to speak of lions and tigers and bears (oh, my!) This, as the text is at pains to point out, is a most scary thought indeed, and confusing too, if you take the notion seriously as applying to your everyday life.

For most western people, of course, all this is purely academic, but it's not so for serious Mahayana Buddhists. Nor is it so for serious Big Bang cosmologists: every Big Bang model, of *absolute mathematical necessity,* implies the "existence" of precisely this kind of "non-existence", viz., at the very moment of the Bang. This ought to scare the bejesus out of the Big Bangers, because their entire finite-universe model collapses right there and then (for if an absolute nothing, which does not even contain nothing-at-all, can thereby contain anything and everything, it could even contain a really infinite universe!)—except that the Big Bangers don't want to discuss such conundrums or even to think about them, declaring that they lie outside the scope of their inquiry, and are not amenable to mathematical treatment. (Which, by the way, is true). And this isn't even a discussion about what went on *before* the Big Bang, which all cosmologists wish away by saying it cannot be discussed in any meaningful manner: it's just a discussion about what was there at the very beginning of the Bang, which as we saw earlier, *can't* entirely be done away with in any model of the Big Bang, even Hawking's.

When you think about it, really, the notion of “nothing at all” has a problem even with ontology, or the science of existence. That is to say, can “nothing” be said the have any existence at all? After all, one of the very *definitions* of “nothing” is “that which does *not* exist”. If anything exists at all, it surely can’t be called “nothing”: it would have to be called “something”. So logically speaking, “nothing” can’t even *exist,* let alone have any properties other than existence.

In fact, until we come up with a satisfactory way of dealing with zero and infinity, whether with the help of mathematics, Buddhism or in any other way, I don’t think it will even be possible to come up with a completely satisfactory cosmology, or theory of the universe, if by the word “universe” we mean “everything that exists”. And this implies that it also won’t be possible to come up with a so-called “Theory of Everything”, such as the one Einstein was working on without success during the last thirty years or so of his life, and like the one Hawking postulates might be discovered some day by theoretical physicists. That’s partly because a satisfactory theory of everything must, if it really *is* about everything, come up with a theory of zero and infinity as well. So to have the one, we’ve got to have the other. If anyone has a better idea, I’d be glad to hear it.

There are further difficulties with the Big Bang model, some of which do *not* have to do with zero or infinity. One of these problems is, that every Big Bang model assumes that gravity alone is responsible for shaping the universe on the largest scale. Now it is well known in physics that there are other forces in the universe besides gravity. The strong nuclear force has a very short range, however, and for large scale phenomena can be neglected. However, both components of the electromagnetic force, namely electricity and magnetism, have infinite range, just like gravity, and are, moreover, immensely (10^42) times more powerful than gravity. Besides, there are two of them, electricity and magnetism, working in concert, each at right angles to the other: which makes for very interesting interactions.

In addition, they have *two* components, attractive as well as repulsive (while gravity is only attractive, never repulsive). The result of these peculiarities is, that if at any stage in the life of the universe there are happen to exist large magnetic fields along with large numbers of electrically charged particles (electrons or protons, basically), then the most interesting, and essentially most unpredictable, interactions occur between them.

...

There is yet a further reason for my avoiding mathematics. This is the principle, commonly accepted by scientists, that a scientific theory should be “elegant”, or “beautiful”. Of course there is no guarantee that an elegant theory is true, while a “messy” one is untrue, but it seems to be more likely that the elegant one is *more* true than the messy one.

Now “elegance” or “beauty” is, of course, in the eye of the beholder. In the past, cosmologists have opted for “beauty” or “elegance” in the form of neat mathematical equations. But by now so many of these mathematical equations have proliferated in the scientific press, that it has become virtually impossible for lay persons to understand what the pros are saying. At this rate, eventually only a handful of people in the entire world will know what's really going on in the universe, while the rest of humanity will have to take their word for it, on faith. It will be a bit like the Dark Ages in Europe, when whatever the Bible said, was "true", and everything that contradicted it was heresy. This, to my mind, is *not* scientifically elegant or beautiful: quite the opposite!

I think the search for scientific beauty and elegance, at least in this day and age, must lie in the direction of simplicity and understandability. If a theory becomes so difficult to understand that virtually no one can understand it, I think it will have failed the test of beauty or elegance. Of course that, by itself, is no guarantee that the theory is untrue, but maybe there's a simpler way of putting it. Or maybe it *is* true, but not as true as another, more understandable (and therefore, in my view, "elegant") theory might be.

It is clear, of course, that no scientific theory is *completely* true: as we said above, all theories yet propounded—except the very latest—have broken down at some point in the past, and all scientists fully expect the latest ones to break down at some point in the future. Indeed it is quite possible—to paraphrase of the words of the Chinese Sage Lao Tzû—that the Reality that can be described, whether in words or equations, is *not* the ultimate Reality, and never can be.

Nevertheless, we (and indeed Lao Tzû himself) have *tried* to describe it, not because it can be done, but because there is little or no alternative. All of us do, of course, *experience* reality for ourselves: and as far as each one of us is concerned, that is the ultimate, raw reality—for instance, when we die, the world most likely *will* come to an end ... *for us;* but if we want anyone else to know anything about any of our experience, we have to try and describe it, whether in words or equations, or even in music or pictures or dance ... imperfect though our attempts are doomed to be.

And in this respect, I personally feel that the imperfection is likely to be lesser if we use words rather than equations. In order for equations to adequately describe reality, all the assumptions tacitly made in formulating the equations have to be correct: and they almost never are. For instance, in the case of Relativity it is tacitly assumed that its equations will be valid for all distances, even those which are infinitely small; but as we know from Quantum Mechanics, it just ain't so. (That was one of the reasons given by Hawking and Penrose for their error in their 1970 paper).

[... to be continued ...]