# *The multiverse, ultimate causation and God*

George Ellis

**Talk at Emmanuel College**
**6th November, 2007**

;

"Multiverses and Cosmology: Philosophical Issues"
W. R. Stoeger, G. F. R. Ellis, U. Kirchner
http://xxx.arXiv.org/abs/astro-ph/0407329

# The idea

The idea of a multiverse -- an ensemble of universes or of universe domains – has received increasing attention in cosmology

- separate places [Vilenkin, Linde, Guth]
- separate times [Smolin, cyclic universes]

- the Everett quantum multi-universe: other branches of the wavefunction [Deutsch]
- the cosmic landscape of string theory, imbedded in a chaotic cosmology [Susskind]

- totally disjoint [Sciama, Tegmark, Rees]

## The big issue

The very nature of the scientific enterprise is at stake in the multiverse debate: the multiverse proponents are proposing weakening the nature of scientific proof in order to claim that multiverses provide a scientific explanation. This is a dangerous tactic.

**Note**: we are concerned with ***really existing*** multiverses, not potential or hypothetical.

**Two central scientific virtues are testability and explanatory power. In the cosmological context, these are often in conflict with each other.**

**The extreme case is multiverse proposals, where no direct observational tests of the hypothesis are possible, as the supposed other universes cannot be seen by any observations whatever, and the assumed underlying physics is also untested and indeed probably untestable.**

**In this context one must re-evaluate what the core of science is: can one maintain one has a genuine scientific theory when direct and indeed indirect tests of the theory are impossible?**

**If one claims this, one is altering what one means by science. One should be very careful before so doing.**

## The motivation

1. - claimed as the inevitable outcome of the physical originating process that generated our own universe

   [e.g. An outcome of the chaotic inflationary scenario]

2. - seen as the result of a philosophical stance underlying physics: “everything that can happen happens”

   [The logical conclusion of the Feynman path integral approach to quantum theory]

3. - proposed as an explanation for why our universe appears to be fine-tuned for life and consciousness

## Fine tuning: The Anthropic Issue

• "The universe is fine-tuned for life" [J Barrow and F Tipler, *The Anthropic Cosmological Principle]*

- as regards the laws of physics [Max Tegmark "Parallel Universes" astro-ph/0302131]

- as regards the boundary conditions of the universe [Martin Rees: *Just Six Numbers*, *Our Cosmic habitat*]

• A multiverse with varied local physical properties is one possible scientific explanation:

-an infinite set of universe domains allows all possibilities to occur, so somewhere things work out OK

• NB: it must be an ***actually existing*** multiverse - this is essential for any such anthropic argument

## **Fine tuning**: *Just Six Numbers* [Martin Rees]

*1. N = electrical force/gravitational force =$10^{36}$*

*2. E = strength of nuclear binding = 0.007*

*3. W = normalized amount of matter in universe = 0.3*

*4. L = normalised cosmological constant = 0.7*

*5. Q = seeds for cosmic structures = 1/100,000*

*6. D = number of spatial dimensions = 3*

## Application: *explaining fundamental constants*

Particularly: explaining the small value of the cosmological constant [Steven Weinberg: astro-ph/0005265; Susskind, *The Cosmic Lansdscape*] by anthropic argument

- too large a value for $\Lambda$ results in no structure and hence no life

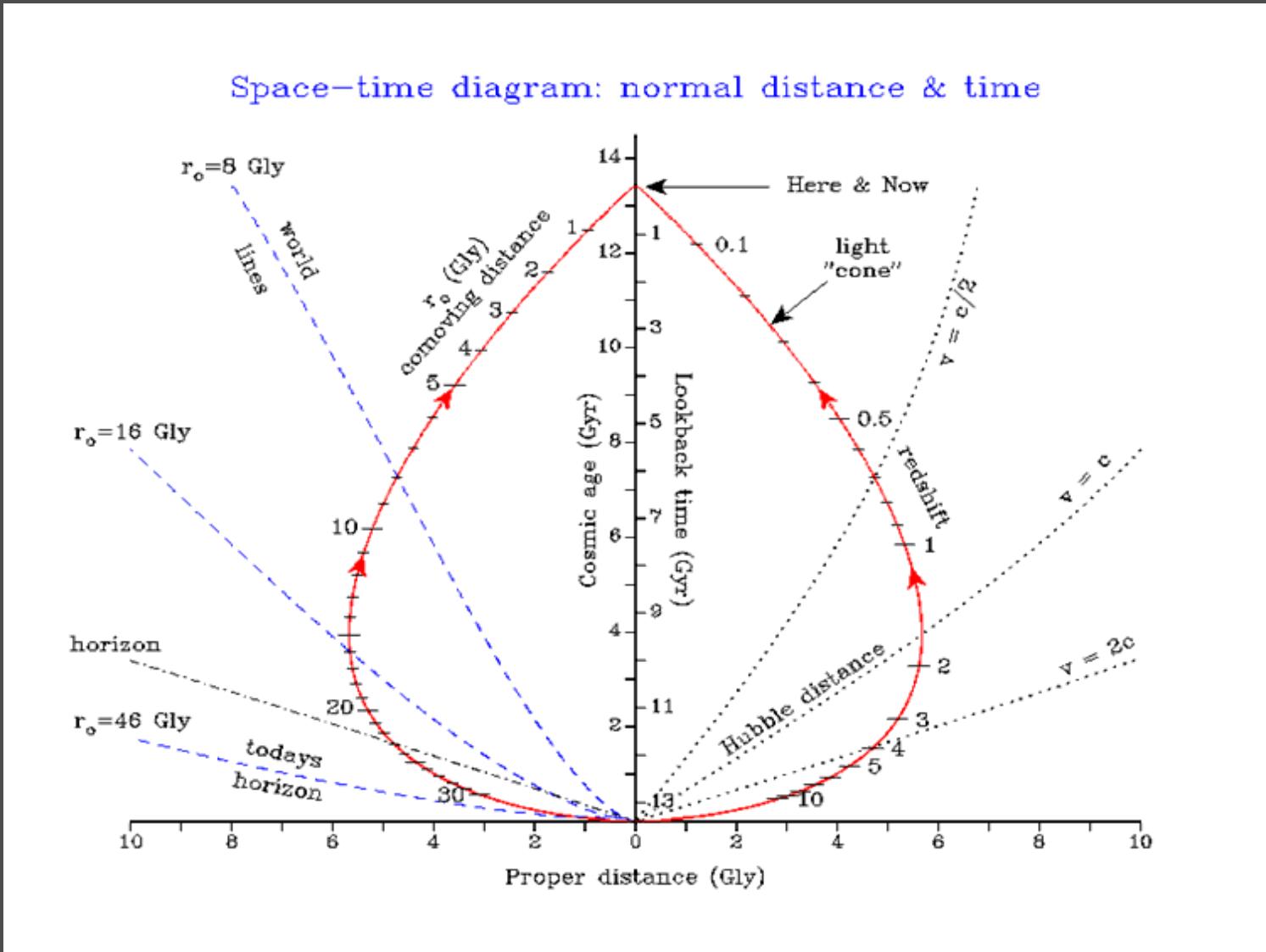
- then anthropic considerations mean that the value of $\Lambda$ we observe will be small [in fundamental units]:
- thus justifying an actual value extremely different from the `natural' one predicted by physics: 120 orders of magnitude

* ***making the extremely improbable appear probable***

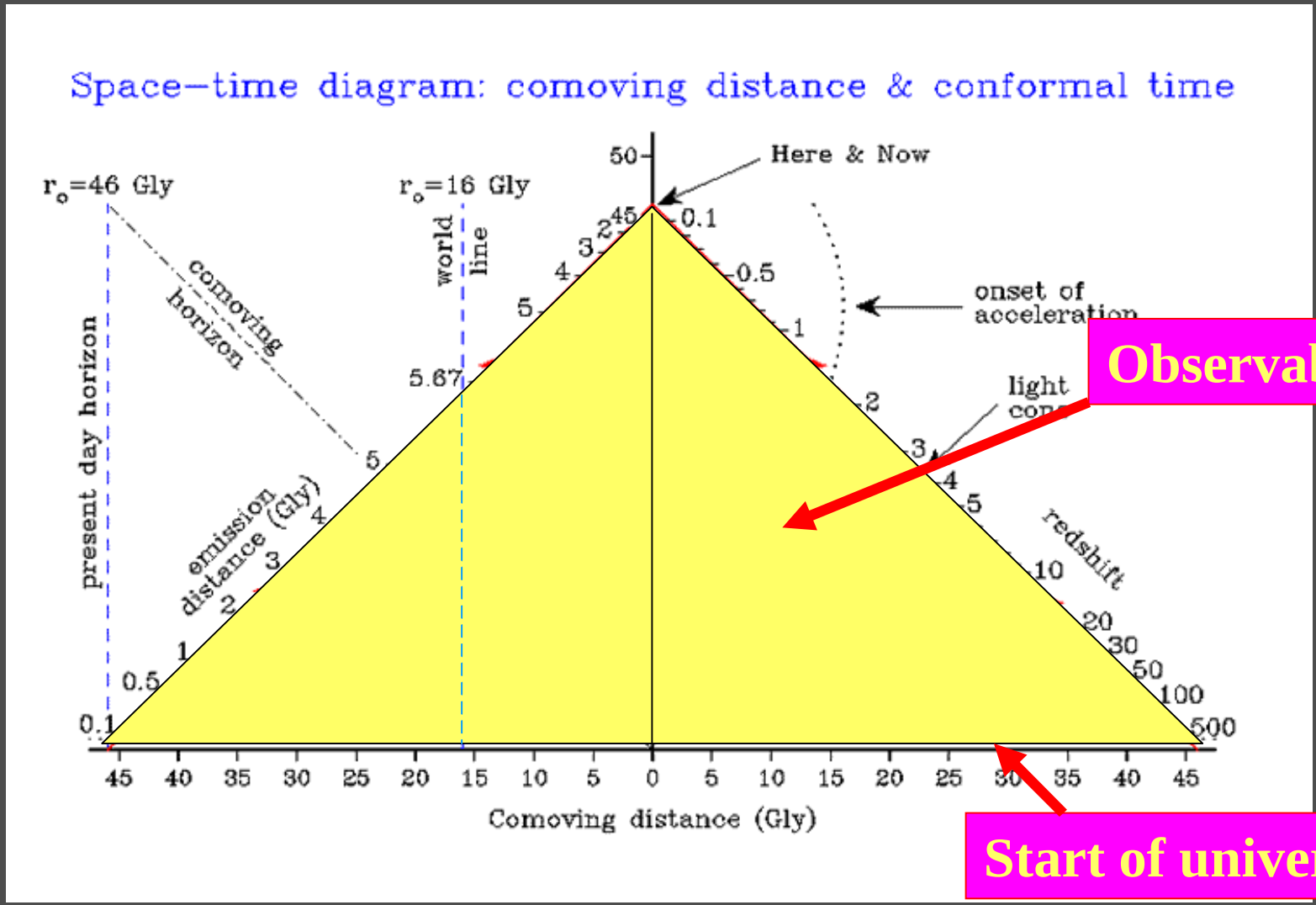
***- the true multiverse project***

# The key observational point is that the domains considered are beyond the particle horizon and are therefore unobservable.

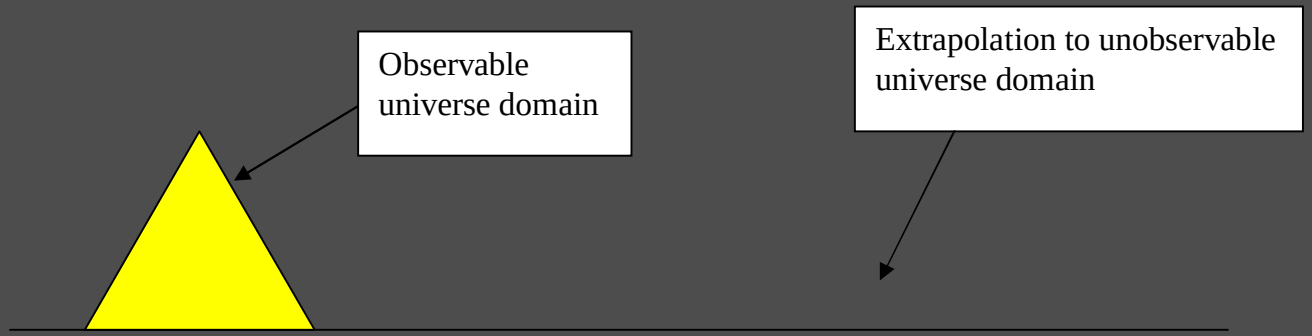
See the diagrams of our past light cone by Mark Whittle (Virginia)



# Expand the spatial distances to see the causal structure (light cones at ±45º)

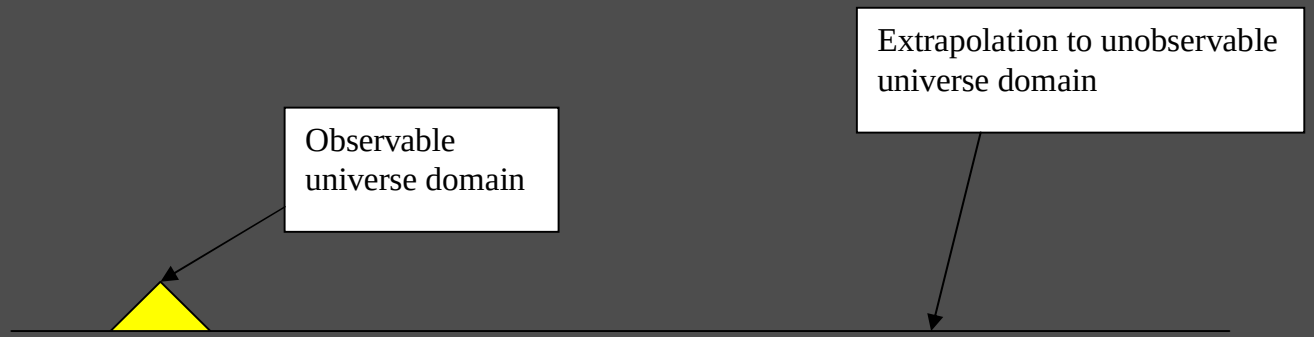


Now it is clear what the observational and causal limits are:




No observational data whatever are available!

Better scale:




The assumption is we that can extrapolate to 100 Hubble radii, $10^{1000}$ Hubble radii, or much much more (`infinity')
– go to Cape Town and we haven't even started!

## Given this situation, what are the arguments and evidence for existence of a multiverse?

1: ***Slippery slope***:

***there are plausibly galaxies beyond the horizon, where we can't see then; so plausibly many different expanding universe domains where we can't see them***

Untestable extrapolation; assumes continuity that may or may not be true. Outside where we can see, there might be (a) an FRW model, (b) chaotic inflation, (c) a closed model, (d) an island universe. No test can be done to see which is the case .

If each step in a chain of evidence is well understood and tenable, then indirect evidence carries nearly as much weight as direct evidence. But not all the steps in this chain are tenable.

If employed leads to the old idea of spatial homogeneity forever (`The Cosmological Principle') rather than the multiverse of chaotic cosmology with domain walls separating phases.

## 2: ***Implied by known physics*** that leads to chaotic inflation

The key physics (Coleman-de Luccia tunneling) is extrapolated from known and tested physics to new contexts; the extrapolation is unverified and indeed is unverifiable; it may or may not be true. The physics is hypothetical rather than tested

**Known Physics** → **Multiverse** ?? NO!

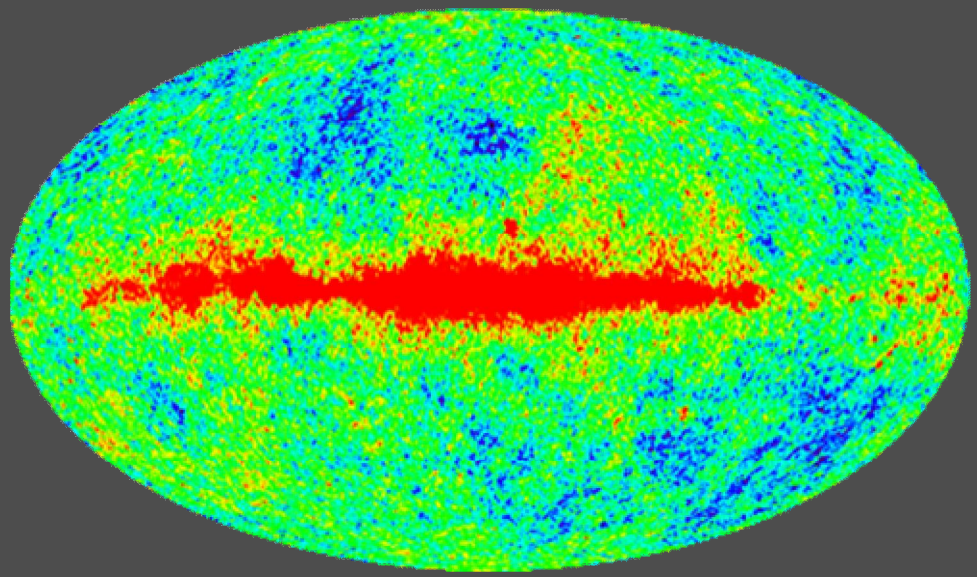
**Known Physics** → **Hypothetical Physics** → **Multiverse**

***Major Extrapolation***

***It is a great extrapolation from known physics.***

***This extrapolation is untestable: it may or may not be correct.***

## 3: *Implied by inflation, which is justified by CBR anisotropy observations*



- **it is implied by some forms of inflation but not others; inflation is not yet a well defined theory (and not a single scalar field has yet been physically detected). Not all forms of inflation lead to chaotic inflation.**
- ***For example inflation in small closed universes***

## 4: Implied by *probability argument: the universe is no more special than need be to create life.*

**Hence the observed value of the Cosmological constant is confirmation.**

**But the statistical argument only applies if a multiverse exists; it is simply inapplicable if there is no multiverse.**

**In that case we only have one object we can observe; we can do many observations of that one object, but it is still only one object (one universe), and you can't do statistical tests if there is only one existent entity**

**We don't know the measure to use; but the result depends critically on it**

**This is in fact a *weak consistency test* on multiverses, that is indicative but not conclusive (a probability argument cannot be falsified). *Consistency tests* must be satisfied, but they are not *confirmation* unless no other explanation is possible**

## 5: Can be *disproved if we determine there are closed spatial sections because curvature is positive: k = +1*

**The claim is that only negatively curved FRW models can emerge in a chaotic inflation multiverse.**

***5a: because Coleman-de Luccia tunneling only gives k = -1;***

**But that claim is already disputed, there are already papers suggesting k=+1 tunneling is possible**

**- indeed it depends on a very specific speculative mechanism, which has not been verified to actually work, and indeed such verification is impossible.**

***5b: because the spatial sections are then necessarily closed and are all that is, if they extend far enough***

- **but we could live in high density lump imbedded in a low density universe: the extrapolation of k=+1 may not be valid**

***Neither conclusive!*** [WMAP data marginally indicate k=+1!]

*However:*

**Chaotic inflation version can be *disproved if we observer a small universe: have already seen round the universe. Therefore spatially closed:***

- **Can search for identical circles in the CBR sky, also CMB low anisotropy power at large angular scales (which is what is observed).**
- **A very important test as it would indeed disprove the chaotic inflation variety of multiverse.**
- **But not seeing them would not prove a multiverse exists. Their non-existence is a necessary but not sufficient condition .**

**6: It is the only *physical explanation for fine tuning of parameters* that lead to our existence,**

- **in particular the value of the cosmological constant**

**[n.b. theoretical explanation, not observation]**

**7: It results from the theory that "*everything that can happen, happens*" (Lewis, Sciama, Deutsch) as suggested by Feynman QFT approach**

**[n.b. theoretical explanation, not observation]**

**Which is more important in cosmology:**

**theory (explanation) or observations (tests against reality) ?**

## 7: The often claimed existence of *physically existing infinities* (of universes, and of spatial sections in each universe) in the multiverse context (e.g.Vilenkin: *Many Worlds in One: The Search for Other Universes*) is dubious

**- infinity is an unattainable state rather than a number**

**(David Hilbert:** "the infinite is nowhere to be found in reality, no matter what experiences, observations, and knowledge are appealed to.")

**- *completely untestable:* if we could see them, which we can't, we could not count them in a finite time.**

**The often claimed existence of *physically existing infinities***

**is not a scientific statement – if science involves testability by either observation or experiment.**

**This claim in the multiverse context emphasizes how tenuously scientific that idea is.**

**It is a huge act of hubris to extrapolate from one small domain to infinity (remember the conformal diagram).**

**It is not remotely testable.**

## Implication of all the above:

**The multiverse idea is not provable either by observation, or as an implication of well established physics. It may be true, but cannot be shown to be true by observation or experiment.**

**However it does have great explanatory power: it does provide an empirically based rationalization for fine tuning, developing from known physical principles.**

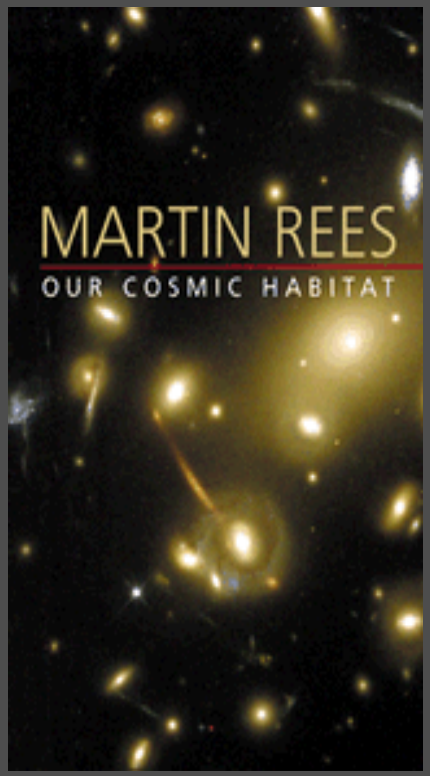
**Here one must distinguish between explanation and prediction. Successful scientific theories make *predictions*, which can then be tested.**

**The multiverse theory can't make any predictions because it can explain anything at all.**

**Any theory that is so flexible is not testable because almost any observation can be accommodated.**

# Our Cosmic Habitat

## Martin Rees




**Rees explores the notion that our universe is just a part of a vast ''multiverse,'' or ensemble of universes, in which most of the other universes are lifeless. What we call the laws of nature would then be no more than local bylaws, imposed in the aftermath of our own Big Bang. In this scenario, our cosmic habitat would be a special, possibly unique universe where the prevailing laws of physics allowed life to emerge.**

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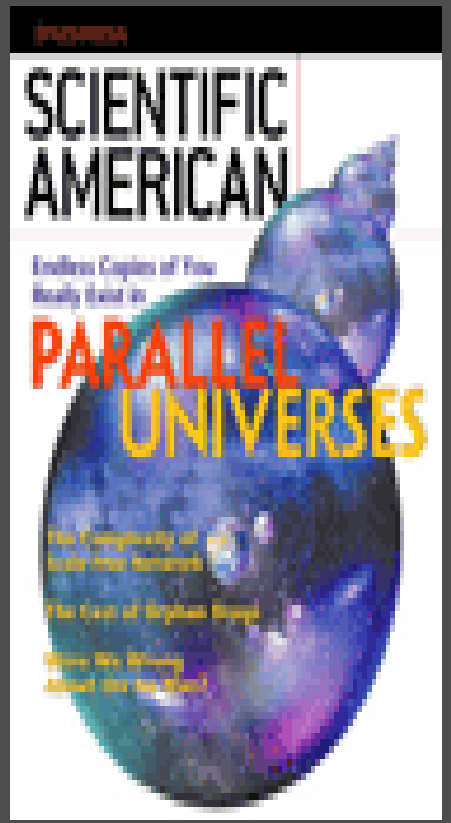
**May 2003 issue**

**COSMOLOGY**



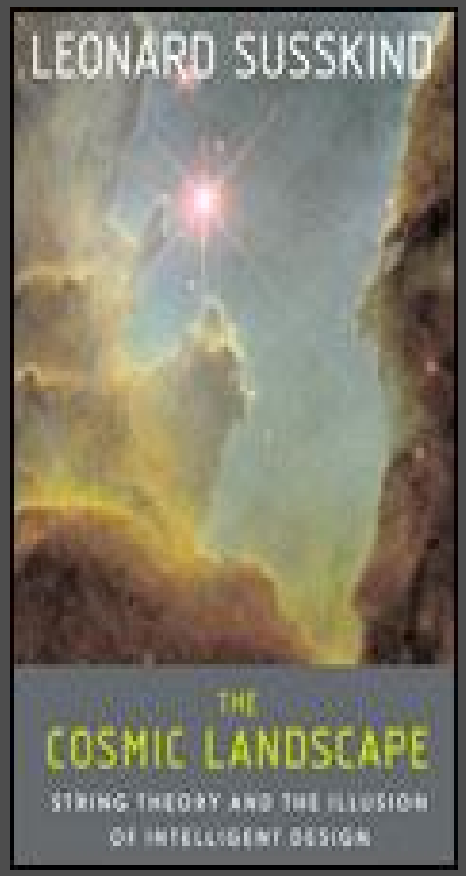

**“Parallel Universes:**
**Not just a staple of science fiction, other universes are a direct implication of cosmological observations”**

**By Max Tegmark**

**Scientifically irresponsible statement!**

# *The Cosmic Landscape: String Theory and the Illusion of Intelligent Design*

## Leonard Susskind



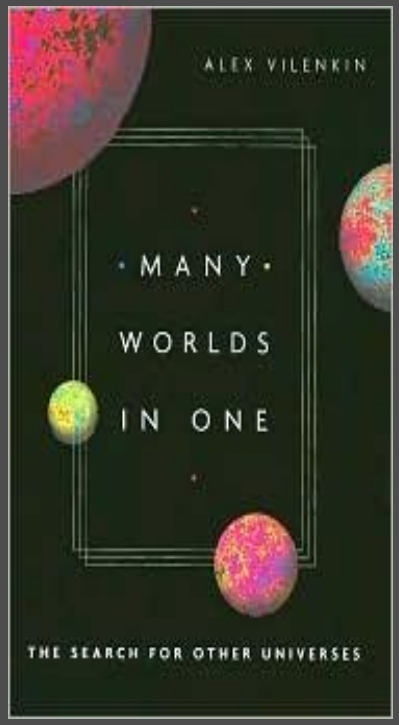

**Susskind concludes that questions such as "why is a certain constant of nature one number rather than another?" may well be answered by "somewhere in the megaverse the constant equals this number: somewhere else it is that number. We live in one tiny pocket where the value of the constant is consistent with our kind of life. That's it! That's all. There is no other answer to the question".**

**"The anthropic principle is thus rendered respectable and intelligent design is just an illusion"**

*Confuses particle and event horizons, and ignores the best data on curvature*

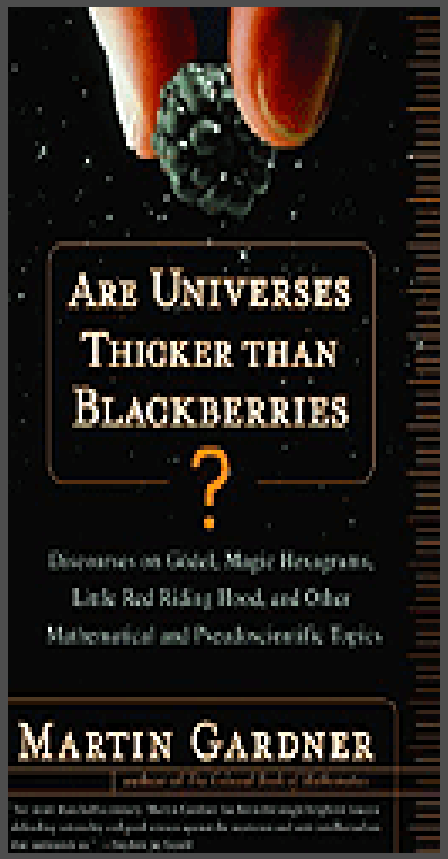
# Many Worlds in One: The Search for Other Universes

## Alex Vilenkin




**“He goes on to posit that our universe is but one of an infinite series, many of them populated by our "clones." Vilenkin is well aware of the implications of this assertion: "countless identical civilizations [to ours] are scattered in the infinite expanse of the cosmos. With humankind reduced to absolute cosmic insignificance, our descent from the center of the world is now complete.”**

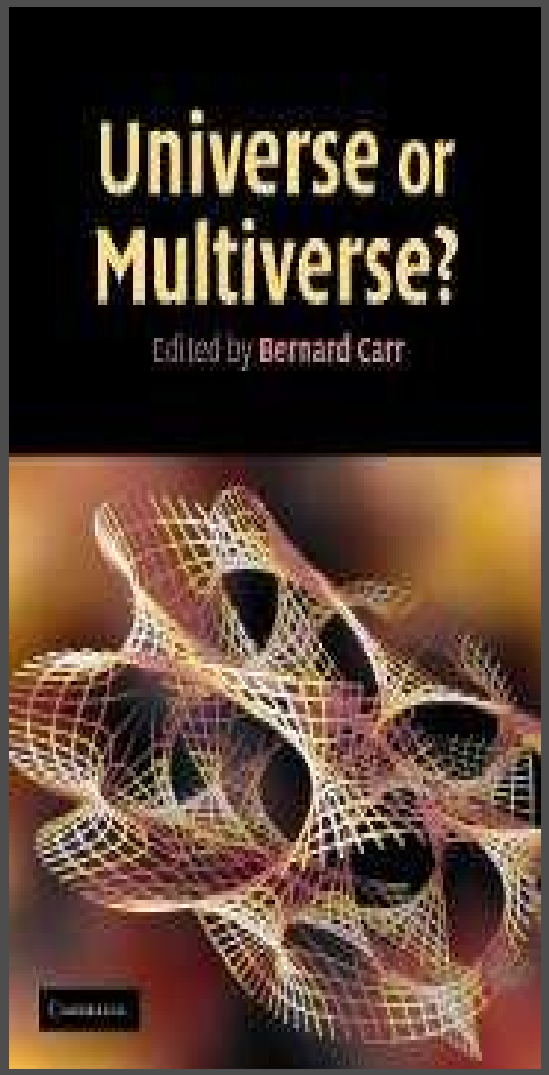
# Are Universes Thicker Than Blackberries?, by Martin Gardner




**One of the most astonishing recent trends in science is that many top physicists and cosmologists now defend the wild notion that not only are universes as common as blackberries, but even more common. Gardner goes straight to the point: the scientists who say this have given no evidence for believing that the possible worlds other than this one, useful though they may be as fictions, have real existence.**

# Universe or Multiverse?

## Bernard Carr




**Recent developments in cosmology and particle physics, such as the string landscape picture, have led to the remarkable realization that our universe - rather than being unique - could be just one of many universes. Since the physical constants can be different in other universes, the fine-tunings which appear necessary for the emergence of life may also be explained. Nevertheless, many physicists remain uncomfortable with the multiverse proposal, since it is highly speculative and perhaps untestable.**

## Implications:

*I conclude that multiverse proposals are good empirically-based philosophical proposals for the nature of what exists, but are not strictly within the domain of science because they are not testable.*

**I emphasize that there is nothing wrong with empirically-based philosophical explanation, indeed it is of great value, provided it is labeled for what it is.**

**I suggest that cosmologists should be very careful not make methodological proposals that erode the essential nature of science in their enthusiasm to support specific theories as being scientific, for if they do so, there will very likely be unintended consequences in other areas where the boundaries of science are in dispute.**

**It is dangerous to weaken the grounds of scientific proof in order to include multiverses under the mantle of `tested science' for there are many other theories standing in the wings that would also like to claim that mantle.**

**It is a retrograde step towards the claim that we can establish the nature of the universe by pure thought, and don't then have to confirm our theories by observational or experimental tests: it abandons the key principle that has led to the extraordinary success of science.**

**In fact we can't establish definitively either the existence or the nature of expanding universe domains that are out of sight and indeed out of causal contact with us.**

**The claim they exist is a belief rather than an established scientific fact. It is a reasonable faith with strong explanatory nature, but a belief none the less.**

**The appropriate statement we can make is not "Multiverses exist" or "Multiverses have been proved to exist" or even "Multiverses can be proved to exist", but rather "That multiverses exist is a useful hypothesis".**

**We should not state more.**

## Issues Arising:

### 1: Is there a philosophically preferable version of the multiverse idea?

I argue that Lee Smolin's idea of a Darwinian evolutionary process in cosmology [L. Smolin, *The Life of the Cosmos*, Crown Press, 1997] is the most radical and satisfactory one:

- it introduces the idea of Darwinian natural selection into cosmology: an extension of physics fundamentals to include biological principles.

However it is incomplete in several ways.

**2: Does the idea of a multiverse preclude the monotheistic idea of a creator God?**

**i.e. is the idea in fact contrary to the idea of a creator?**

I argue that the answer is No, as already foreshadowed by Olaf Stapledon in his book *Starmaker*. The ideas can exist together.

God could have chosen to operate via creation of multiverses.

***The multiverse proposal says nothing about ultimate causation (chance, probability, inevitability, design):***

***All the same anthropic issues arise as for a single universe:***

***Why this multiverse, and not another one?***

**Purely physical arguments encompass only a part of the data available to us; Physics only encompasses part of the causal nexus in the real universe**

***There is indeed meaning in the universe, no matter what eminent physicists may say. It undoubtedly exists. If it did not, you would not be here!***

***There is for example also good reason to believe in a moral reality – absolute standards of good and evil. Even Dawkins and Stenger do! (else they could not proclaim that religion is evil)***

How does it arise? Can it come from nothing, or does it reflect an underlying aspect of the nature of the universe? One can claim the latter makes more sense: and applies either to a universe or multiverse. It is a quality of existence that reflects what truly exists.

“I like to walk alone on country paths, rice plants and wild grasses on both sides, putting each foot down on the earth in mindfulness, knowing that I walk on the wondrous earth. In such moments, existence is a miraculous and mysterious reality.

People usually consider walking on water or in thin air a miracle. But I think the real miracle is not to walk on water or in thin air, but on earth. Every day we are engaged in a miracle which we don't even recognise: a blue sky, white clouds, green leaves, the black, curious eyes of a child - our own two eyes. All is miracle.”

- *The Miracle of Mindfulness.* T N Hanh

"I say to myself as I watch the niece, who is very beautiful: in her this bread is transmuted into melancholy grace. Into modesty, into a gentleness without words. …..

Sensing my gaze, she raised her eyes towards mine, and seemed to smile .. A mere breath on the delicate face of the waters, but an affecting vision. I sense the mysterious presence of the soul that is unique to this place. It fills me with peace, and my mind with the words: `This is the peace of silent realms'.

I have seen the shining light that is born of the wheat."

- *Flight to Arras.* Antoine de St. Exupery

"I believe with all my heart and mind that there is a spiritual dimension to all being that cannot be encapsulated in scripture or in creed; an essence that loses its creative force when its communication depends upon the use of words alone.

It can it think be readily made manifest through metaphor in poem or story;  yet I am deeply aware that even when presented in such a form the truth remains partial.

For me, there is a reality that lies beyond our presently misdirected concern for the fruits of economic power. It is only when we acknowledge our deeper inner need to discover meaning in existence that we begin to harvest the fruits of the spirit."

- *Lewis Watling*

"Most of us are at least partially aware of epiphanies that come our way from time to time: the emergence when rounding a corner of a breath taking panorama of mountain, forest and ocean; the sudden sensibility of a zephyr breeze rustling treetops; the scent of jasmine on a shower of rain.

I believe there are illuminations far beyond these: intutitions, insights, divinations that are not shaped by the physical senses: the hand of a friend on one's shoulder in a time of trouble; the sudden recognition of s smile in a passing stranger; above all, the wondrous inspiration of the serendipity, synchronicity, and innate knowing in the fabric of our lives.

More often than not gifts such as these, which indelibly inscribe themselves upon our memories, are regarded as gifts of God"

- *Lewis Watling*

# Intimations of Transcendence

- Morality, ethics
- Aesthetics, beauty
- Companionship, Love
- Creativity, science
- Creation, existence
- Spiritual experience
- *broad experiential evidence about the nature of the universe*

  *- or any multiverse that includes us*

**3: Do the arguments against *realised infinities* in this talk argue against the concept of infinity in relation to the nature of God?**

I end up agnostic on this one, but tending to say Yes.

The key point is that the concept of `infinity' is used far too casually in physics and theology alike.

The concept `transcendent' should do.

## 4: Does a multiverse imply the idea of multiple Gods?

I argue against this: one God could have created a multiverse rather than a single universe.

However note that if one proposes the idea “everything that can happen, happens”, one then can reasonably argue that some universes will have a creator God, and others not!

The issue is what is prior: the multi-universe mechanism, or God? This idea can perhaps help throw light on the nature of Creation

## 5. Is the idea of a multiverse useful?

- in a naturalistic context, yes.
  It has explanatory power.

- in a theistic context it is unnecessary,
  but a small number of other universes is palatable.
  A great many is not. Such numbers are in any case not needed for explanatory power, in this context.

But it does raise the interesting issue:
Does God need to learn as He/she creates universes??
Did he/she get it right first time?
Or did he/she need to learn from experience??

## 6. Is the degree of faith required to believe in a multiverse more or less than that required to believe in a creator God?

I argue that because of the lack of conclusive evidence in both cases, the degree of faith required to believe in either is the same.

Both can be argued on the basis of reasonable extrapolation from known data. Neither is in fact provable.

Despite scientific appearances, belief in a multiverse is an exercise in faith.

# 7. Does a multiverse in fact exist?

I have no idea.

You can believe what you like.

What do you find aesthetic?

What gives you greatest comfort?

**Does an infinite multiverse exist?**

- almost certainly, No.

Martin Gardner puts it this way: "There is not the slightest shred of reliable evidence that there is any universe other than the one we are in. No multiverse theory has so far provided a prediction that can be tested. As far as we can tell, universes are not even as plentiful as even two blackberries" (*Are Universes Thicker than Blackberries*? (Norton .2003).

For defence of the idea, see Rees, Tegmark, Susskind, Vilenkin, Deutsch: *The Fabric of reality: The science of parallel universes* (1998), and Lewis: *On the Plurality of Worlds* (2000).