TOWARD AN IMPROVED COSMO-LOGICAL SYNTHESIS

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There is a persistent tradition implying simple and unassailable logical foundations — as yet undiscovered — for the whole of cosmology. The tradition, which peaked in modern rationalism, continues strong in contemporary cosmological speculation. Thus, for example, recent rationalistic theories of the universe, ambitiously aimed at mathematico-logical expression and capture of nature. Thus, for example, the bottom line to the many theoretical enterprises of Wheeler:

> Little astonishment should there be, therefore, if the description of nature carries one in the end to logic, the ethereal eyrie at the center of mathematics. If, as one believes, all mathematics reduces to the mathematics of logic, and all physics reduces to mathematics, what alternative is there but for all physics to reduce to the mathematics of logic? Logic is the only branch of mathematics that can 'think about itself'.[1]

Logic reassumes its ancient role as the fundamental science; the Word expresses a logic recipe.

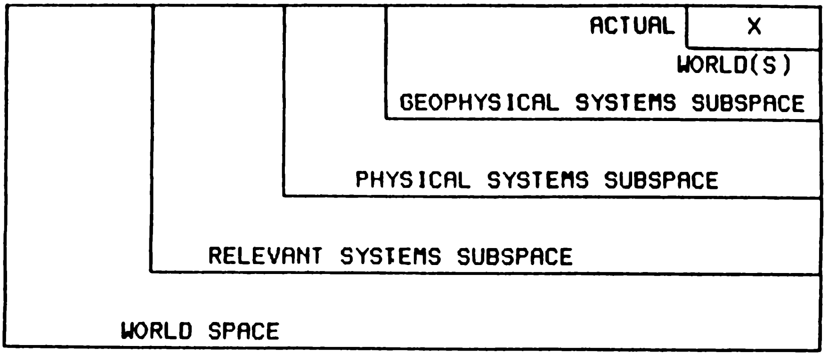
Even while abandoning some of the illusions of grand reductionistic schemes, and undermining the Enlightenment power quest for the logical keys to the theoretical capture and control of the universe, there is much of a more modest character that recent logical theory, as liberalised by semantics and nonstandard systematisation, can contribute to the organisation of a unified world picture.

The synthesis outlined in what follows fits into this more modest

1. This passage from Misner, Thorne and Wheeler, p. 1212, is given an appropriately grander setting in the text. The passage is also quoted by Davies, G p. 222, who ascribes it to Wheeler. In Davies the idea of 'simple and unassailable logical foundations' for cosmology is given a different exposure, and is then linked with restrictions, to zero, on God's range of choice of universe to make.

setting. It is achieved by suitably relocating cosmology as a part of semantics (generously construed, for example, to admit contextual elements). So unified, then, are "universal" semantics, relevant semantics and cosmology, as suggested in a preliminary way in diagram I.

DIAGRAM 1: *Underlying Worlds Picture*



Comment. The subspaces are marked out by closure requirements, that of relevant systems by closure of each world under deducibility (relevant derivability), that of physical systems by closure also under physical laws (suitably formulated in terms of conditionals). The actual (or better *factual*) world is a select world common to the nested spaces.

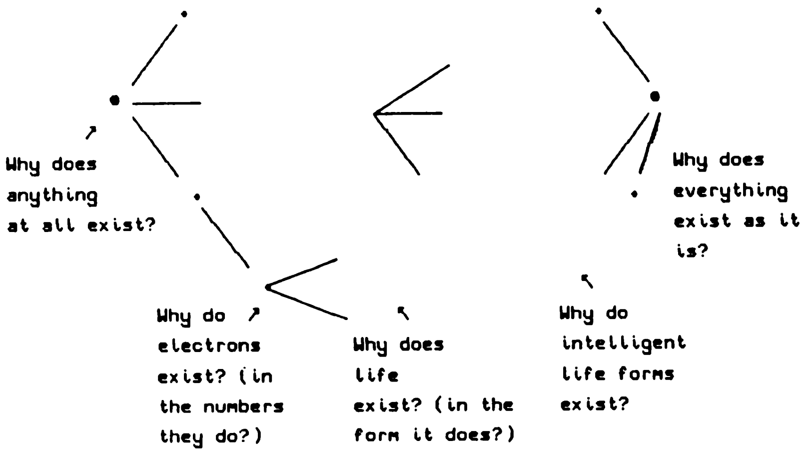
The underlying idea of the synthesis is simply this: a subspace of neutral worlds semantics is also a suitable framework for cosmology, for an *interpretation* of the logical theory of the universe as a whole. In less condensed form, the idea is that the alternative worlds semantics arrived at in the pursuit of a universal semantics (a general semantics for all languages) and, connectedly, as part of the theory of all objects, be applied also in fundamental physics, most importantly to the matter of the origin, history and physical features of this cosmos, but as well elsewhere, in particular in the interpretation of quantum theory. And in the case of quantum theory there is already, most conveniently, a many-universe or world-ensemble theory, ready for neutral stripping. That is, the theory can be recast in existentially neutral terms, without the original objectionable ontological load of world-ensemble theory, in terms of nonexistent worlds. Not surprisingly, in the recasting the theory *is* changed (e.g. the unobservable world splitting of the Everett interpretation gives way to future-directed world branching).

The setting in terms of objects which do not exist, other worlds especially, is essential. For one reason, the idea grew out of investigation (for UQ) of what is normally taken to be a philosophical question, indeed by some such as Heidegger as the fundamental question of metaphysics, namely 'Why does anything at all exist?'. Reset in world terms this becomes a question of the selection of a world such as that we find ourselves in which contains something existent (us among other existent things) as opposed to an alternative world, which contains nothing — a much more tractable question. But the recasting loses explanatory merit should all the worlds involved be taken to exist. For then the old objectionable circle is simply reentered, explaining existence in terms of more existents. Here the circle is broken, as it is elsewhere (particularly in cosmology: cf. JB chapter 2), by *explaining what exists by way of what does not.* It is the failure to duly allow for and acknowlegde this pattern of explanations though it is common practice in the theoretical sciences, that has made issues like the 'Why does anything exist?' question seem so intractable.

In fact the Heideggerean question is only the first of a lattice of questions concerning the character and nature of the cosmos in which we happen to be that are liable to be asked[2], up to 'Why is this cosmos (just) like it is?' to which world modellings may fruitfully be applied, as an important first step in eliciting some answers.

2. Especially by those whose inquisitiveness and sense of wonder has not been blunted or destroyed by the mainstream culture and its educational practices, practices much mainstream philosophy reinforces and tries to justify.

DIAGRAM 2. *(Bounded) lattice of questions.*[3]



In the reorientation of worlds semantics from languages to cosmologies, from language to "the" world, there are certain features that should be kept firmly in view — apart from such notorious features as that among the worlds of the modellings are a range of bizarre, absurd, incomplete and maverick worlds, and that each (nonexistent) world has a domain of objects which, though it includes a subdomain (perhaps null) of entities, typically contains nonexistent objects, both possible and not, physically realisable and not. Namely, the feature of world selection should not be lost sight of. For instance, in assessing truth, a factual world T is selected — in one way or another, but typically by a choice function on a circumscribed class — and holding evaluations are worked out (recursively) at T. For (relevant) deducibility a subsystem of derivationally closed worlds is defined; for possibility a subsystem comprising consistent worlds is marked out; for

3. Indolent philosophers tend to assign those of these questions that they cannot write off (e.g. as semantically defective or as betraying philosophical confusion or hang-ups) to science. But they are not just a matter for science; and scientists tend to come up with philosophically loaded, and often enough naive, theories insofar as they address the questions at all. Too many scientists remain, like too many Australian philosophers, in the grips of awful metaphysics, such as narrow empiricism and/or physicalism.

natural law likeness a subsystem of physical worlds is distinguished[4]; and so on for the cases of subsystem and group selection.

§1. *The many worlds approach to the "Why does anything at all exist?" question.*

There are many canvassed answers to this question, and still more ways of trying to dismiss it. All the disposal attempts are defective, and most of the canvassed answers are unsatisfying (so Griffin and I devote a good deal of space in UQ to showing). One approach that is not inadequate — but permits however development in several different directions — is the many worlds approach.

It is true (and argued elsewhere, e.g. JB) that

A) Some things exist.

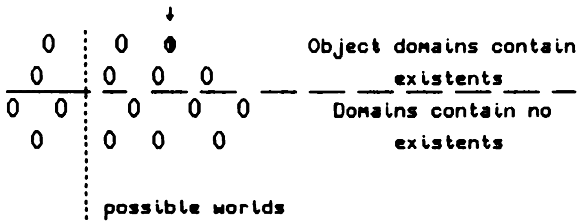
This truth enjoys a modal status, that of contingency in fact. But, to begin, a weaker claim suffices, namely

C) It is contingently true that some things exist.

For the obvious existence that most things enjoy or regret is contingent. The truth of the more controversial claim that nothing necessarily exists, can be left for the present.

Neutral worlds modelling of theme C) yields directly a many worlds picture, with some worlds, including the actual world T, containing existents, and with some possible worlds containing no existents (but perhaps some nonexistents). It can be likened to a display of balloons:

DIAGRAM 3: *Static picture of a world modelling for theme C).*

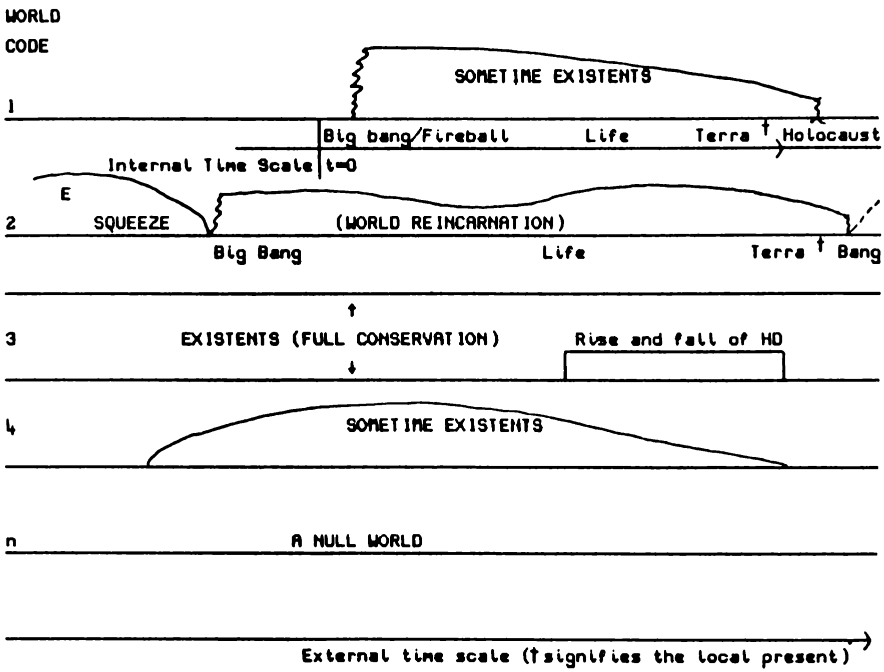


4. The semantical analysis of 'it is a natural law that' is in terms of law-constrained worlds, *natural worlds.* The interpretation rule is like that for necessity.
It should be noted that geophysical features, applied in selecting geophysical worlds, are not of course confined to Terra, but apply to other planetary systems.

Such a neutral modelling begs no serious ontological questions, involves no ontological prodigality. For it is not assumed that any of these worlds exist, in any way. (It is not difficult to represent what does not exist.) Nor need it prejudice matters unduly against necessity themes such as God-hypotheses. For even if it were mistakenly insisted, as against the straightforward interpretation of C), which allows it is necessarily true (under some necessity determinable) that some things exist, a related many worlds picture would result; the dashed line would simply move down the diagram). But let us stick with what is right, C).

It is more revealing to take theme C) as tensed — after all *existence is existence now* (JB chapter 2) — and to introduce, what further investigation will require, dynamical modellings. then, whith some evident embroidery, the following picture emerges:

DIAGRAM 4. *Dynamic picture of worlds modelling of theme C), with sample universes*



Comments. Much is presupposed in the way the picture is drawn (e.g. that some measure of existents can be obtained, by way of particle numbers); but these presuppositions can be modified or removed.

The same sort of modelling serves also to validate themes linked to C), such as

D) There may have been a time when nothing existed.

Consider the crucial matter of T-selection, i.e. factual world selection, (or of G-selection, i.e. referential sub-world selection). This is done in terms of certain features these worlds have, such as containing entities, including observers, exhibiting life, manifesting intelligence or mind — to anticipate features coming up and sometimes proposed for world selection. Such selection picks out *this* world from the ensemble of worlds (*our* world also, as it happens). And the world thus selected includes existents.

Why does anything at all exist? Because this world, T, includes, happens to include, existent objects. To this extent it is a matter of fortune — good fortune, it might be hazarded, since the world exhibits enough that is good and enough potential for good. As a contingent matter, this world contains (in its object domain) items that exist. So T-selection delivers a world making it true that some things exist.[5]

The answer seems trite; but that is in large part because the question and answer are taken in isolation, apart from issues as to the details of the process, the *how* questions, such as

H) How does it happen that something exists?

The issue can be considered in terms of mass-energy, since everything that exists is ultimately of this kind (so it is argued in JB chapter 9). To the question

H') How does it happen that some mass-energy exists?

two sorts of answer are possible.

Firstly, there is the conservative answer: some always existed. There is an endless ongoing sea of mass-energy, which simply fluctuates, moves, recycles, etc. There are plenty of problems with this answer; for

5. An elaboration of this type of answer can be further exploited to help explain why the actual world of standard science is so comparatively simple, mathematically tractable, etc. Namely, it is conveniently so because the actual world selection implicitly involved serves to render it so, by choice of a world with the complexity of richer worlds removed and only tractable ideal elements (such as scientific universals) adjoined.

instance, physical problems, such as how did the Big Bang of standard cosmology occur, what was happening before it? But there are alternative mathematical stories now being told, for instance, of a massive singularity located in space (rather than at physical time $t = 0$ as with the Big Bang), which try to offer a physical account of a continuous universe (see e.g. G. Ellis). And the singularity stories offered can be enriched (along lines rather like what will be ventured in the case of the second answer). Almost all traditional philosophical and theological accounts, virtually all paying homage to ontological assumptions, should be included among the conservative, existence-always answers. But the nonmaterialist account among these characteristically involve level shifts. Then the appeal is back to the existence of God or the (ultimate) One, who, on a higher level, serves as eternal sustainer, and perhaps fashioner, of the material universe. The conceptual and other problems of such answers are sufficiently notorious.

Secondly, there is the radical answer: at some stage nothing existed, at that time, before the Big Bang, there was no mass-energy. The difficulty for this picture is how mass-energy ever appeared from the macroscopically tranquil sea of nothingness. It is no great feat to get past that ancient problem of how something can come from nothing. The long-received orthodox prejudice, that from nothing nothing comes, ex nihilo nihil fit, is invariably reinforced by mistaken ontological assumptions (see JB, chapter 2). But even when these ontological assumptions are set aside, there is the awkward matter of causal mechanism.

But an unlikely story can be told, a myth related, explaining how something may (suddenly) emerge from nothing, a jet of mass-energy from the sea of nothingness. The story borrows from the quantum theory of the vacuum (or rather, of suitable vacuums). There is suddenly an avalanche of energy "borrowing", and mass creation of particles in a concentrated area.[6] This is the Big Bang (at internal time zero). It is unique (in experience) because such a singularity is very improbable. (Even a Small Bang would be rather improbable.) The net energy "borrowed" is borrowed on a very long term (at high interest?),

6. Alternatively, through quantum borrowing and positive feedback, a massive fireball forms. The story admits of much variation.

with a gradual replayment plan. This ties with principles of thermodynamics, concerning the eventual run-down of this universe. On this story, it will eventually (though perhaps over a very protracted time) subside back into nothingness. From nothing everything existent originally came; into nothingness everything existent will ultimately process.

It is one thing to devise such a story, or rather the outline (or scaffolding) of a story; it is another to condense it into science. But before scorn is poured on such a story, let it be noted that the story is less bizarre, and more informative, than the set-theoretical myth of the construction of the entire universe from the null set — certainly a construction, insofar as it encompasses existent individuals, of something existent from nothing, since the null set certainly does not exist (despite orthodox claims to the contrary).

There are reasons for preferring the second style of story to the first — though it may appear to some to violate conservation principles such as that of mass-energy: in fact it need not. One is that the endless mass-energy story fails to account for the presence of mass-energy. By contrast, nothingness does not require explanation: it is, so to speak, the rest position. In terms of the range of possibilities here, existence is what is *un*usual, what is atypical, what especially calls for explanation, *not* nonexistence.[7] Hence the explanatory superiority of the radical answer.

7. The problems, as the questions of the lattice in diagram 2 indicate, lie with explaining what *does* exist, not what does not. In a related way, all those philosophers' papers on the problems of nonexistence and nonexistents have misjudged the problematic, and misconceived the onus of proof. For commonly the problems concern existents and their behaviour; nonexistents, especially those functioning in explanatory roles as regard existential behaviour, are often very well behaved by comparison with existents.
It has been suggested, by D. Lewis, that the underlying theory of items (of JB) renders everything nonexistent, and makes it a real problem, how anything exists. But it is patently false that the theory of items render everything nonexistent. There are criteria for existence, which are often satisfied (cf. JB, chapter 9). Every thing nominalists normally take to exist satisfies the criteria. Beyond that existence has to be justified; it cannot (with any pretension to satisfactoriness) just be claimed, in the fashion of so many philosophers. In any case, Lewis can be simulated: whatever *individuals* exist

As one might expect in varying such an obvious and ancient story, and is easily discovered, scientific condensation and assessment has begun, especially in the last decade. The idea that the total energy of the universe is zero was considered a human generation ago by Whitrow[8], reflecting on Mach's philosophy of motion. More recently, Tryon has argued the zero total energy theme, assuming a closed universe and appealing to the standard treatment of gravitational potential energy as *negative* energy.[9] If the universe contains just enough mass to close it, then the negative energy must more or less exactly cancel the energy (mc^2) involved in the existence of that mass. Hence, even a cosmos as impressively large and ancient as this universe can exist through borrowing, through quantum vacuum fluctuation on a grand scale in a relativistic setting. Such vacuum fluctuations can occur by dispensation of the uncertainty principle $\Delta E.\Delta t \sim \hbar$; when the mass-energy of ΔE of a physical object approaches zero, its lifetime Δt can become very large.

Only the merest beginning on removing certain objections and obstacles to such a more scientific story will be attempted. Firstly, there are, inevitably it seems, ontological and verificationist objections. These turn however on assuming that a vacuum and empty space must somehow exist, at least by way of some sort of existing container or outer shell. Such assumption are mistaken. Such objects as vacuums and unoccupied space are nonexistent objects with distinctive and mathematically assessible properties. Though they may not be accessible to observation, and in this respect are *outside* the range of *experience*, there is *sufficient information* concerning them for exacting investigations to be made of their features. Similar points tell against

in Lewis worlds will exist in worlds-selection theory. And it *is* a genuine philosophical problem how anything exists.

8. Apparently, in 1946; see his cosmological text. Whitrow also applied, more than a quarter of a century ago, what has now been elevated to the Anthropic Principle, in his answer to why the dimensions of space are three; namely, that this alone permits the evolution 'of Man, the formulator of the problem' However 'Whitrow's reasons concern not *mankind* but stable planetary orbits and complex neural networks' (L1, p. 144).

9. Compare the binding energy which keeps electrons bound to a nucleus, where correlatively energy stored up in overcoming forces of repulsion is positive.

the objection that it is wrong to impose an external spatial or temporal measure on (mass-energy) closed space-time; for example, to inquire what happened before the Big Bang, or to embed the curved space-time of the universe in a larger spatial or temporal setting. As a matter of fact, many cosmologists exhibit no unease in asking what happened before the Big Bang even when assuming no matter before that, though verificationism would no doubt rule such questions out as meaningless or otherwise out of order. More to the point, bounded metrics can always be extended (Hubble time is just one example), and sometimes fruitfully, though verificationist bounds are exceeded. Another mistake has been to assume that Nothing, since nonexistent, is entirely without structure or organisation and ungoverned. Indeed two diametrically opposed polar views of it have prevailed, and even been run together: of Nothing as chaotic, and so excessively rich, and of Nothing as entirely blank, and so excessively impoverished. Both are inadequate.

A more interesting ontological objection (raised by Armstrong) is that such an account of the origin of the universe takes for granted the existence of natural laws, and so does not explain how something existent came from nothing. Such objections confuse truth with existence, after the fashion of neo-Platonism. Laws hold, but do not exist — by contrast with neo-Platonic views, where laws are relations of universals, which exist. On object-theory (such as that of JB), however, universals do not exist, and so laws are not thus existentially loaded. Once truth is duly separated from existence, there is of course the further question of why the laws that hold or evolve do hold. But this is a separate, and vexing, question of ultimte explanation.[10]

Secondly, there are more technical objections; directed against the

10. However a story could be told to bring laws within the explanation framework. It would invlove telling how the laws first evolved or happened to hold, before vacuum fluctuations. (For some interesting speculation, from which the ontic and anthropic commitment can be removed without total loss, see Barrow pp. 151-2, where "chaotic gauge theory" is considered.) The issue of ultimate explanation is taken up again in UQ, especially the matter of a self-justifying postulate as serving to resolve the problem of ultimate, reflexive, explanation. Note that the Characterisation Postulate of object-theory is an initially promising candidate for such a principle.

admittedly shaky physical account; for instance, that fluctuations with the quantum numbers of the vacuum will consist equally of matter and anti-matter, whereas features of the universe suggest imbalance. But it now seems that a *very* slight — and so it is said, *delicate* — imbalance early in the evolution of the universe after the Big Bang is just what is required for present features of the universe; and such an imbalance, permitted on recent (GUT) theories, catastrophic fluctuation hardly excludes. A third connected obstacle used to be serious: it has been presupposed that a quantum state can be assigned to the whole universe.[11] But that is now alright; for according to (neutral adaptation of) the Everett many-universe interpretation of quantum theory, a state function Ψ covers the behaviour of the physical worlds P (with $T \in P \subset K$), which presumably evolve according to a relativised Schrödinger equation of the form SE(Ψ). To explain some of the recent appeal of this sort of world-ensemble interpretation, it is important to turn to the interesting and curious matter of the physical constants.

§2. *The matter of constants for physics and some of their neat interrelations.*

The matter of much recent interest is the setting or adjustment of certain constants; the claim is that it is surprisingly delicate, and that if the constants (and some of their constant ratios) were different by only small margins, then the actual universe would be a *very* different, with the result, among *many* other things, that we shouldn't be here to observe any of its local passing show.

11. Another serious issue is that, on the story as told, quantum phenomena assume decidedly macro-dimensions. Of course they may, as the parable of Schrödinger's cat illustrates, but perhaps not in the supposed catastrophic form. In the absence of any approved quantization of general relativity, there are only lax physical controls on what is in and what is out in speculation here. And, of course, the second story could be elaborated in other ways. There are other mechanisms for the sudden rise of mass-energy, e.g. white holes in geometrodynamics.
In his second paper, Tryon makes a rather casual beginning on meeting some of the difficulties with the vacuum fluctuation theory of the cosmos, and explains the advantages of combining the theory with that of a (still problematic) "inflationary" universe, to boost the fluctuation. But the theory still awaits appropriately detailed development and modelling.

Now the possibility of explanations of the specific values of these constants in terms of physical theory itself is not so far excluded. Perhaps no constants in physics are ultimately fundamental, though that seems unlikely. Various ways of eliminating constants are now familiar, e.g. some represent scale factors and are eliminated by re-scaling or new choice of coordinates. Others are removed by more radical ways of relooking at things, as in Einstein's treatment of gravitation. But some resist elimination — so far.

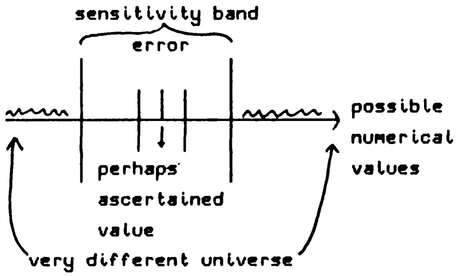
For, in any case, what is fundamental depends on the given shape of physical theory, and some previously fundamental constants (such as Avogadro's number) have turned out to be derivative as theory advanced and new (deeper) constants were introduced. There is the remote possibility, obviously cherished by some scientists, that in the end all physical constants can be removed, that a constant-free (grand unified) theory in which all constants can be removed will result. This is not obviously impossible in the way that a complete elimination of logical constants from logical theory is, that a final triumphant removal of the Scheffer stroke from classical propositional logic is impossible.

However, it is too much to expect that a "deep mathematical analysis" can always do the job. For one thing, explanations of this sort do give out. There is an argument for this from the backward proceeding character of deductive explanations to more general premisses (from the content inclusion of deduction proper). There are no mathematical analyses without mathematical assumptions, without a system of postulates. The hope (expressed by Carter and others) that generally deeper underlying theories can be found, will not always be fulfilled, of necessity.

Since transformations, such as scaling, alter or remove constants, can transfer the Big Bang back to minus-infinity, and so on, there is no solid data to explain, underlying the allegedly problematic numerical features (so B. Ellis, for one, contends). While it is true that which constants feature, and what their values are, will depend on initial choice of units, whatever that choice, at least some of the constants will emerge. Thus there will be features and values which require explanation, and explanation of the same broad type, however the transforming is done. For the present, and immediate future at least, there is no getting rid of the constants, and while they continue to figure their numerical values and ratios set some tricky problems.[12]

There is the matter, first of all, of describing the relevant physical data in a neutral non-prejudicial fashion. The facts of the matter are more or less as follows: — Present physical theories include many (physical) constants, which occur in the formulation of laws and principles. A number of these constants are *fundamental*, in that they are not derived from other constants (or deduced from deeper physical theory). Two things have been noticed concerning fundamental constants of present physical theory, both of which call for explanation:

1) If the values of certain constants lay outside a rather narrow band (surrounding their perhaps ascertained value), gross features of the geophysical universe would be different. Call this — hopefully without prejudice, since its contraposition represents the substantial core of the "anthropic" principle — the *sensitivity* feature.



For the record, the *geophysical principle* resulting from contraposition takes the following form: certain gross features of the geophysical universe are only possible *in present form* if the numerical values of

12. There are various other issues concerning the physical constants, including the question of the (slow) evolution of "constants" over time. Well, if they do evolve, the same sort of problems arise for the parameters which replace them (i.e. at each time t, for c(t)).
There are putative arguments to the effect that there can be no very grand unified theory, and no final elimination of constants, because any such theory would do too much in *determining* the world (and things). But it is unclear at present how such an argument gets duly elaborated. A tight argument for the uneliminability of *some* physical constants from physical principles would be of much interest.

certain constants lie within a narrow sensitivity band. Examples of such gross features are island galaxies, long-lived stars, planets, hydrogen, water, carbon, heavy metals. All the recognised physical forces, for instance, exhibit the sentitivity features. To illustrate, if the strong nuclear force were marginally stronger, nuclei could grow much beyond the present limits and all hydrogen would long ago have been converted to helium, with the result that there would be no long-lived stars (of present type) and no water. On the other side, a decrease in the strong force would prevent the formation of nuclei of heavy metals. A dozen further examples and more of similar sensitivity may easily be assembled from the physics literature.

2) The *Pythagorean* feature. Large numbers arrived at in astronomical computations turn out to coincide (to within order of magnitudes). Perhaps the most famous of these 'large number coincidences', as they are mostly called, is Eddington's relation, stating the number of particles in 'the visible universe' is the inverse square of the gravitational coupling constant. (Many other examples are assembled in Bondi.)

These two *numerical* features are interconnected, most importantly in that sensitivity features are (or can be) used to explain large number coincidences.[13]

These numerical features are cited 'as evidence justifying the introduction of various exotic theories (e.g. involving departures from normally accepted physical conservation laws) of which early examples were the "varying G" theories of Dirac and Jordan'. So writes Carter, who appeals to some differently exotic principles, anthropic principles, in order to explain the numerical features within the now received cosmological setting. With the help of these anthropic principles he canvasses, as he puts it, 'the opposite thesis: i.e. that far from being evidence in favour of exotic theories these coincidences should rather be considered as confirming "conventional" (General Relativistic Big Bang) physics and cosmology which could in principle have been used to predict them all in advance of their observation' (p. 291) — a large claim that is far from evidently established. But large

13. This is what is really accomplished in Carter. To some extent we have emerging in this area a contemporary scientific numerology.

claims on flimsy foundations are the order of the day in cosmology. Of course speculation is fine, and may be great fun. It is with the conversion of this stuff to in received wisdom, or even knowledge, that caveats should be entered, especially when the distillation is prejudicial, e.g. in that it points to favoured conclusions such as design (for humans) in the universe.

Much capital has already been made of the numerical features, of what is referred to — you can see the loading straightaway — as a 'catalogue of extraordinary physical coincidence and apparently accidental co-operation' (D p. 110). Here is a typical beat-up, by Davies:

> The structure of the physical world is *delicately* dependent on a variety of apparent numerical *accidents*. Many of the rather basic features of the universe are determined in essence by the values that are assigned to the fundamental constants of nature, such as G, α, m_p and so on, and these features would be *drastically* altered if the constants assumed even moderately different values. for *nature to produce* a cosmos even remotely resembling our own, many apparently unconnected branches of physics have to *co-operate* to a *remarkable* degree (D p. 111; some of the prejudicial terminology is italicized).

The last part is particularly weak: so our ignorance of interconnections is disclosed, ignorance we might have forestalled if Carter is right. All the argument from 'apparently unrelated topics' serves to reveal is lack of an integreted theory of physics: the present theory is bits and pieces, which resist fitting together. Nor do large number coincidences point to any hidden co-operation, but rather to overlooked connections which can be argued towards (as by Dicke, Carter and others) using fairly conventional physical equations.[14] As for the *hidden purpose* terminology, 'for nature to produce ...', well, the justificatory case for its use is not merely not evident, but entirely lacking. The same applies to other terms which Davies and others infiltrate, such as 'conspire' (D p. 111), 'fine-tuned', 'delicately balanced', all of which suggests agents with certain purposes.

Related objections should be lodged against some of the *improbable happening* terminology, 'accident', 'coincidence', etc. A contingent

14. Convergence arguments, e.g. for such things as the Church-Turing thesis, suggest underlying connections, but no co-operation.

world need not be accidental; it is not accidental that Griffin lives in Troy, Ontario, though it is contingent certainly. An improbable world need not be accidental either. 'Accidental' means, according to the *Concise English Dictionary* (CED), 'Occurring by chance, unexpectedly, not according to the usual order of things; advantitious, non-essential'. The general thrust of the notion is decidedly misplaced for the actual world; and 'accidental universe' is a misdecription.[15] To be sure, there is some considerable slackness in terms like 'accidental', which can come close also, when applied as in scholastic theory, to meaning contingent. The term 'coincidence' nicely illustrates the well-known vacillation, as its CED definition makes plain: 'The act, fact or condition of coinciding; a remarkable instance of apparently fortuitous concurrence'. The large-number 'coincidences' are of the first type; there is little case for making them out as of the second type.

To argue, however, that the actual world is not merely contingent, but *improbable*, it is hardly necessary to go so far afield as advanced physics. Some more homely examples will do, such as matter of all the lucky golfers who have managed holes in one. Or consider the following argument from contingencies, to the improbability of the actual world.

Take some contingency, e.g. that person 1 in some ordering of the audience is wearing a green top. She might have been wearing any other colour. Say there are 100 shades to choose from in the clothing colour cards. Then the probability that she is in green is no more than 1 in 100. But the same sort of probability holds for every other person presently wearing a top, and these probabilities are largely independent, say in 1 (US) billion cases, i.e. 10^9 cases. That is, the probability of the present array of tops is no more than 1 in 10^{11}. That already makes present arrangments exceedingly unlikely, before we go into the colours of other bits of apparel people are customarily bedecked in, the colours of books, of motor cars and so on. So even surface contingencies lead towards the conclusion that the actual world is astronomically improbable.[16]

15. Even less, seemingly, is the universe an accident, 'an event proceeding from an unknown cause; something unexpected; a casualty, a mishap...'.

16. If however the world really were necessary, such improbability must be grossly reduced. How can that be: how can these contingencies be not what they seem?

Nonetheless, the situation with the fundamental constants does differ. An *important* difference between these day-to-day improbabilities, such as that we have the spouses we do, and those the constants induce is this: — Even if all these things (colours, e.g.) had been different, the world would not be a *very* different place. Contrast the constants: their significant variation would make the world a very different place. Is there a difference in kind, with a *radical* improbability in degree? Only in degree, bridging examples tend to suggest. The same broad picture will serve for the range of cases, for everyday and cosmological contingency.

§3. *Back to many worlds: improbabilities and the universal quantum theory.*

Where that broad picture leads — so the sought synthesis suggests, as does an increasing amount of cosmological theory — is to the many-worlds interpretation of improbability. Quite evidently, worlds semantics are not the only semantics that can be offered for probability. But few other semantics offer similar universality and informativeness, and some of the alleged competitors (not to be taken too seriously as rivals) face damaging circularity in this area, e.g. probabilistic semantics, urn semantics. The idea of the modelling is naturally this: 'It is improbable that you have the spouse you have', is true by virtue of the fact that in only a few worlds, including the actual one, of the modelling do you have your current spouse; mostly (insofar as you occur) you do not.

In precisely the same way cosmic improbabilities, such as particular numerical values for physical constants, lead to many universe modellings. This is the argument to many-universes *from improbabilities*. The description of the physical situation requires probabilistic notions, e.g. 'extraordinary coincidence' of constants, 'remarkable features', etc. But semantics of probabilistic notions calls for alternative worlds. (Thus Davies' golf example and Leslie's archery example). Of course Davies sees worlds used for probabilities as a *conceptual* device (D p. 126); Everett sees them as *real*. What we have is replay of universals issue! But universals do not exist, and nor do these explanatory worlds. Not only do the improbabilities lead to a many-nonexistent-worlds picture; conversely the multi-universe theory explains the improbabilities.

The *envisaged model* contains a huge collection of worlds. The worlds reflect the range of (natural) values of the fundamental constants. All initial arrangements of matter and motion are reflected in worlds (at least within a certain interval of accuracy);[17] the chances of the present universe resulting is thus exceedingly small, which exp!ains various improbabilities. Does it matter that we can't normally quantify these improbabilities? Any more than we can quantify the (large) probability of nuclear war? No; there is something offensive about the repeated demand for quantification.[18]

Quantum theory affords a *similar* many worlds picture, at least for circumscribed situations, the state function is a superposition of several alternative physical situations. 'On measurement, one particular world — the actual world — is selected, apparently at random' (D p. 124). One problem with a complete universe state function is that 'to measure a system we must have some measuring apparatus that is not itself part of the system. ... When the system is the entire universe, the notion of a piece of external measuring apparatus is meaningless' (D p. 124). So emerges the familiar conundrum for quantum theory presented along orthodox (von Neumann) lines: 'If there is nothing left with which to measure [or otherwise interfere with] the state of the universe, how can the universe make the transition from a superposition of many possible worlds to one, concrete, *actual* world?' (D p. 124). There is, Davies asserts, 'only one comprehensive resolution'[19], a

17. How many worlds? Continuously many worlds? There is no reason why not. But the short answer is: as many at least as required. In object-theory numbers don't matter so much, though technical control is an advantage. There are difficulties as to measures, e.g. of fewness, in infinite modellings. Yet the notions are in order, e.g. among the natural numbers primes are few.

18. This point, and the specific inestimability of probabilities (e.g. in meteorolgy) is argued, though in insufficient detail, by Toulmin among others. By the way, surely a creator would have increased probabilities by *seeing to* a universe fit for decent habitation; a variation upon the argument from evil infiltrates itself in probability guise here.

19. There are in fact *many* proposed solutions, most of them not worked out very far (because they have only few proponents), most of them not *comprehensive* certainly (but it could be argued that this is a false ideal), several of them discussed by Everett, DeWitt, Lande and others.

many-universes interpretation, which 'accept[s] the simultaneous reality of *all* the possible alternative universes' (D p. 124).

But, given the route we have come it is easy to see that there is an ontically neutral alternative to this, direct from object-theory. This alternative assumes many universes also, but *only one* at any stage is actual. The obvious claim is that the probabilistic spread of quantum states does not require existent states, any more than the range of alternative dress states for someone probably attired in green, requires the existence of the person in different clothes. Measurement now shows which world/state an object such as an electron or person is actually in. In these terms it does not *collapse* the probability wave packet, or set of worlds, but marks one out. What isn't known before measurement is which world (or narrower set of worlds) is actual (or the actual electron is in). 'When the entire cosmos is encompassed within the quantum description, nothing is left to collapse the wave' (D p. 125). Rather nothing in the way of external measurements is available to determine *which* is the actual world; however internal information can be made use of in the usual experimental ways.

To set the Everett many-worlds and the contrasting neutral worlds interpretations of quantum theory in perspective, here (adapting DeWitt and Graham) are some leading features:

i) A separate classical sphere external to any and every quantum set-up is not required; it makes sense to consider and investigate a state vector for the whole universe.

ii) The state vector covering the total system (of universes) never collapses, and so the totality it describes can be deterministic.

iii) What is described through the comprehensive state vector and the dynamical variables jointly, is not the actual world but a system comprising many worlds. (On the Everett interpretation these worlds are all equally real; on the neutral interpretation they are not, other worlds than the actual lacking of any sort of reality.)

iv) Through chronological development of the dynamical system variables, the state vector decomposes naturally into orthogonal vectors reflecting a progressing branching of the universe (and system of worlds) into a set of mutually unobservable worlds. (On the Everett account this is described as a continual splitting into equally real worlds; but not in neutral theory)

v) In each world "good" measurements yield definite results, and in many worlds, including the actual, familiar statistical quantum laws hold, indeed can be derived or approximated.

Since the neutral version directly avoids many of the objections to the Everett theory, what is the case for the Everett form? In main part it consists simply of mistaken ontological assumptions, an overactive Reality principle, such as that what has physical properties must exist.[20] The further argument that all branches must be equally real, is not compelling. Thus DeWitt contends:

> Because there exists neither a mechanism within the framework of the formalism nor, by definition, an entity outside of the universe that can designate which branch of the grand superposition is the "real" world, all branches must be regarded as equally real (p. 178).

But we can easily include actual world selection (as well as other kinds of group world selection) within the framework; and given this the intended conclusion does not follow.

It has been objected (e.g. by Lewis) that the neutral world interpretation encounters difficulties the Everett realist-relativist theory avoids. To be specific, there is, in the first place, a demarcation problem not faced by realist theories such as Everett's. Secondly, the neutral theory is too permissive regarding such worlds. In fact, however, the neutral theory *is* restrictive about worlds; and few or *none* of worlds of contemporary realists (such as Lewis) get into the picture, since all such worlds include as existents certain universals. Only neutralised analogues of such worlds appear (see also fn 7). In any case, the theory can be as restrictive as is appropriate about which worlds are *physical*, or physically possible. Requisite subclasses such as physical worlds can be marked out through conformity to physical laws and framework requirements (e.g. that the ensemble forms a Hilbert space). Moreover it is an illusion that realism solves the relevant demarcation problem. It simply covers it up, in an unsatisfactory way.

To highlight some of what is different in the neutral interpretation,

20. Wheeler's sequential model offers a similar range of worlds, but one after another, so satisfying the "reality principle". Earlier Wheeler had adopted a theory (like certain Eastern cosmologies) with multiplicity in both dimensions, sequentially and into the possible; but recently he has abandoned the latter, partly on erroneous ontological grounds.

let us vary a couple of stock illustrations of the ontic many-worlds interpertations, in a neutral way. Consider first the familiar two slit interference affair. On a straightforward realistic approach, 'we appear forced to conclude that *each* electron traverses *both* slits in a wavelike form' (Leslie L1, p. 146), that is to the dialectic interpretation that the electron goes through both slits. The many worlds approach avoids contradiction[21], allowing the electron to traverse just the left slit in the actual world; only in another world, branching from this, the electron traverses the right slit, and this induces probabilistic interference with the other electron. The wave function provides a superposition of two *possible* cases, not two actual cases.

In the transition from physical (or potential) worlds to the actual one, other worlds are not 'destroyed' (as Leslie suggests in his criticism of many-worlds theory). Nor is the interaction of worlds causal. There are few or no causal effects even on the Everett reality version; thus splitting is not seen, not actually observed (cf. virtual worlds, relations, etc.). Though there are transworld interrelations on object-theory these do not exist as further entities. The critical point is that physical worlds are not probabilistically independent. But that's alright; since probability is an intensional matter, probabilistic interference is unproblematic (cf. "possibility" interference).

Consider next Davies' scattering example where an electron is fired at a proton. The probability wave in such scattering represents a set of worlds for the electron. 'The quantum wave provides a measure of the probability of finding the electron at the location: where the "wave" disturbance is greatest there the electron is most likely to be found' (D p. 124). Measurement determines the location, and so alters the probabilities, *thus* on the orthodox view reducing the wave. According to the Everett interpretation, however, 'on measurement the universe divides into two, one containing a right moving electron ... Each world is equally real ... The conscious observer also splits, one copy inhabiting each world.' Even on the Everett interpretation this is inaccurate, since it is not upon measurement that splitting occurs; for the neutral interpretation it is down-right misleading. There is no splitting; rather in quantum processes world-

21. It is of course not the only realistic-style interpretation which does this: Lande's interpretation is another.

branching takes place, so there is a certain near-replication of worlds. But only one world is actual, and represents *the* (real) universe. Measurement can determine which this is, so amending probabilities, and thus, since a new state function results, appearing to collapse the wave. All that happens with world branching is that, because of the uncertainties guaranteed by scattering, the possible physical states of universe, corresponding to the probability wave, are increased. Where there was one possibility for the actual world in this regard, now there are N many (N mirroring the possibilities).[22]

A many-worlds interpretation of physical theory provides a natural setting for principles which select among worlds, as anthropic and geological principles serve to do.[23] And in this setting *explanations* (of varying adequacy) *of all the* numerical *features can be furnished*. For, in the first place, there will always be some universes where the numbers and conditions (for coincidences) come out right. It is only these, furthermore, that are observed [by *us* etc.]. 'It is then *no surprise* that we perceive a universe to which so many special conditions pertain, for we have selected it from the ensemble by our very existence' (D p. 126). But again, talk of *our selecting* is misleading (though of (natural) selection is not). It is rather that, as a contingent matter, we happen to inhabit such universes.[24] And it omits the important point that *further* work is required, for satisfactory explanation — that plausible arguments, *not* involving us,

22. From a neutral viewpoint, it is entirely false that 'We must envisage every atom as constantly engaging in this type of scattering activity, thereby splitting the world again and again into a stupendous number of carbon-copies of itself. The universe must therefore be likened to a tree, which branches and rebranches' (D p. 125). Nor is the tree-stuctured *system* of universes the universe.

23. To anticipate, what happens is as follows: — The antecedents of "anthropic" schemas of the form, "If there exist so and so (e.g. observers) then any physical worlds must be such and such", are applied to narrow the class of physical worlds. As there certainly do exist so and so, physical worlds are restricted to those that are such and such.

24. It is still reasonable to ask why — indeed to 'pose' several why questions, e.g. why do we inhabit it?, whence a long evolutionary story. Why are the constants those they are?, then alternative answers, including *brute fact*, are among the possibilities.

connecting gross geo-physical features with numerical features have also to be supplied. In this way, 'using the world-ensemble hypothesis [but] with[*out*] the weak anthropic principle, it is possible to discover plausible arguments to pin down the values of almost all of the fundamental parameters' (D p. 129, but negating a central part of his claim). Indeed Davies holds out the prospect of being able to do much more, constraining the dimensionality of space and time, the number of quarks and leptons, numbers of fundamental forces, etc. That would really give a synthesis of considerable power. It is a synthesis, moreover, which can be absorbed or simulated within a cosmo-logical synthesis, upon neutralising many-worlds quantum theory and replacing the weak anthropic principle by world selection principles. Nonetheless Davies, like many physicists, is uncomfortable with any such synthesis, any such grand picture. Mostly he seems to hope that contingencies will all be explained as necessities of physics. But the hope is misplaced; in the main it represents 17thC rationalism over again. Sometimes, however, he seems to feel design in the universe.

§4. *What is supposed to emerge, and does emerge, from the numerical features: anthropic principles vs. world selection principles.*

What is supposed to emerge depends upon how the matter is set up, how the picture is presented, what is emphasized. For example, Davies and Leslie both set things up so only two options are supposed to be open. In the Preface to his book, *The Accidental Universe*, Davies suggests the systematic alternatives are either religion or an anthropic principle; a similar claim appears in Leslie, who puts the alternatives as (ethical) necessity or anthropic assumptions. Thus his conclusion (to L2, p. 81)

> The cosmological evidence can supply ... forceful grounds for viewing at least one of these things as true. (1) God is real, though presumably as a creative ethical requirement rather than as a divine person who literally designed our life-containing cosmos. [So the universe exists because it should.] (2) There exists a world Ensemble [so the conditions leading to life are bound to occur somewhere (L2, p. 55)] — and the attempt to derive all the fundamental characteristics of our cosmos from some unified Field Theory is in error.

Davies insinuates that the obvious inference from the catalogue of numerical features is this: 'a hidden principle seems to be at work, organising the cosmos in a coherent way' (p. 110). This runs parallel to argument from design, and is hardly an improvement. *One* of the hidden principles is the God hypothesis; but another Davies (unlike Leslie) really favours is the *anthropic* principle, 'a guiding principle which serves to fine-tune the cosmos to incredible accuracy' for us (humans) — or for observers, or intelligence, or life, or life-supporting systems, or ...? Or not *for* anything.

The choice offered is really then an old familiar one, faced by thinkers at least since the (so-called) Enlightenment: God or Man, or after a recent first correction and with a different emphasis, Humans or God. In fact buried under this duality is, as already glimpsed, at least a three-way choice: Physics (Science) or Humans or God. However the much favoured Physics option, which tempts many a scientist and philosopher, is increasingly seen as excluded, as forbidden fruit or even as 'in error'. And it *is* excluded, as we have seen: there is no (comprehensive) physics without metaphysics, no scientific theory without large assumptions — which stands on its own. But further afield there is yet another option, which is not excluded: the far-out object-theory (deep-ecological) option canvassed. The claim to be elaborated is this: no principles of a type not already required for low level semantical purposes (namely, world selection principles) are called for in explaining the numerical features at least as satisfactorily as the other options succeed in doing. Neither humans nor gods are essential. Since gods do not figure in anthropic principles, the focus will be upon humans, upon removing humans (and, incidentally, such popularly associated more god-like features such as intelligence) from a new special place in the universe.

As already foreshadowed, the anthropic principle comes in a *variety* of forms, mostly pretty colourful for mainstream physicists, none very precise (including Barrow's biocentric reformulations). Some examples will give the impression: — 'The idea is to relate basic world features to our own existence as observers' (D. p. viii); 'our own existence can be used as a biological selection effect, to explain the otherwise mysterious numerical values of the fundamental physical constants' (ibid). This presents several issues to disentangle; for removing underlying mystery is very different from explaining the numerical features. And these may in turn have further explanation, of various sorts, or they may be simply contingent, reflecting selection without specific purpose. Some physicists go so far as to claim: 'our existence *constrains* the structure of the universe, indeed it even "selects" it' (D p. 112); 'for us', to quote from Hawking and Collins. 'Invoking the human connection in this sweeping context has been dubbed the *anthropic* principle': this is Davies' formulation of the principle (D p. 112)!

But *quite generally* the arguments advanced, which do show what work the principle does, have nothing specifically to do with humans, or with intelligence, or with life, etc. The Dicke argument, for example, designed to explain Eddington-Dirac coincidence, is based only on the presence of heavy elements, and so gives but a hint of biology, if that. So really there is no reversal of 'the spirit of the Copernican revolution' in this fashion (*pace* D p.115, Carter, and others). The conditional principle established by the Dicke argument is essentially

J) If [because, given] there exist heavy elements, then the universe is such that the Eddington-Dirac coincidence holds.

The full explanatory argument comprises, as well as the detailed physics that goes toward J), the modus ponens inference:

J^{+}) There exist heavy elements, J) The Eddington-Dirac coincidence holds.

More generally, the anthropic principle gives way to a physically argued conditional *scheme* of the enthymematic form

K) if F then T,

or its contrapositive

K') If not-F then not-T,

where F is a relatively hard factual claim or more commonly its existential "generalisation", and T is a more theoretical claim typically concerning features of the world, such as numerical features. The short form of "anthropic" explanation, or better *status quo explanation*, is then the argument form

L) F, if F then T T.

Moore's familiar ontological proofs, for instance of an external world from the fact that hands exist, are just such arguments. The difference is that philosophers' "proofs" typically omit the solid argumentation that goes into establishing the conditional schemes of *status quo explanations;* for instance, Moore makes little effort in this direction, and the required entailment rather evidently fails to hold (see fn 30).

Other formulations of the anthropic principle are hardly better. Leslie, who at least (like Barrow) moves humans off centre stage, puts it in this counterfactual way: 'if our universe had been [everywhere] hostile to life then nobody would be observing it' (L2, p. 66). If the consequent simply contextually implies that something alive is doing the observing, then the principle is analytic, and scarcely up to the intended explanatory tasks (without the requisite information that the universe contains life being separately pumped in). While if the consequent does not require this, it appears false; the latest seeing-eye robot did survive the holocaust, or did just happen as a result of the quantum vacuum fluctuation. In any case the formulation lacks sufficient generality; it fails to connect appropriately with most purported applications of the anthropic scheme, such as Dicke's argument. The other version of the principle Leslie offers faces related difficulties: 'Necessarily we conscious beings observe a world which is life-containing' (L1, p. 141). As it stands, this is false. We mightn't exist. Nor will appropriate deletion of 'we' fix things. We might retain consciousness but not be observers, being all in vats. But repaired the version is pretty useless. It bears only tangentially (through its consequent, that the world is, but contingently, life containing) on what is at issue concerning numerical features; the material on us, on observers and the like, is strictly irrelevant, a hang-over again presumably from bad idealist constructions of quantum theory.

The idea that the Copernican principle has suffered some sort of set-back because of the eventual role of anthropic principles in explaining large-number coincidences, can be traced back through Carter, who helped popularise the role of anthropic principles and made the (rather obscure) distinction between weak and strong anthropic principles. According to Carter, there has been 'exaggerated subservience to the "Copernican principle" [which is] that we must not assume gratuitously that we occupy a privileged *central* position in the universe' (C p. 291). The regrettable tendency has been to extend the principle 'to a most questionable dogma to the effect that our situation cannot be privileged in any sense ... (in extreme form .. the "perfect cosmological principle" ...)'. The *latter* assumption is certainly untenable (as Dicke pointed out) because the universe is by no means spatially homogeneous on a local scale and special conditions (of temperature, chemical environment) requisite for terrestrial life, do prevail on Earth. But *its* removal does nothing to undercut the Copernican principle, or to boost the anthropic principle in the way Carter thinks it does. For his bracketed comment after his first formulation of the anthropic principle is that 'although our situation is not necessarily *central*, it is inevitably privileged to some extent' (C p. 291). It is doubtful that our position is central; whether it is so privileged depends on the intended contrast, but whatever the privilege is, it hardly seems inevitable.

Carter gives several non-equivalent formulations of the anthropic principle, the first of which takes the quasi-analytic but ambiguous form, 'What we can expect to observe must be restricted by the conditions necessary for our presence as observers' (C p. 291; repeated D p. 119). This is certainly not the same as Davies' condensation of it, what he calls the *weak* principle, that 'observers restrict the observed'. On the obvious (but less charitable) construal, this is but rampant verificationism, of a type familiar however from interpretations of quantum theory. What exists is independent of observers; and observers, especially remote ones, may have no significant impact on what is observed. The condensation is accordingly false. So also, for different reasons, is what it condenses. For one thing, our expectations may run astray. True, what we observe is restricted by the conditions for our doing just that, namely being present as observers. But this tautology imposes no physical constraints, being equally true for Xing as observing; and no such connection is appealed to in any of the derivations of coincidences that Carter sketches. Once again the arguments never have anything in detail to do with humans, or even "observers" (and surely animals observe). At best the arguments are directed to the presence of water or carbon 12 or some such — things sometimes erroneously equated with life, and often, rather dubiously, said to be necessary for life.[25]

The situation is of this sort with Carter's "illustration" of the *weak* (or better *local*) anthropic principle, which he formulates as follows: 'we must be prepared to take account of the fact that our location in

25. Leslie tries to make a case for such a necessity claim. But it appears to be roundly defeated by the sorts of considerations advanced by Feinberg and Shapiro.

the universe is *necessarily* privileged to the extent of being compatible with our existence as observers' (C p. 293). In order to get to grips with this recondite formulation let us remove the initial intensional functors (which my empiricist friends try to assure me are not essential in physics, despite their ubiquity, and physicists' proclivities to modals). Now our position can hardly be *necessarily* privileged (despite Carter's italicization), since human-types might just be uniformly distributed through the universe or again might not exist at all. What necessity there is enters in a different way. What we are left with after due deletion, is then: 'Our location in the universe is privileged to the extent of being compatible with our existence as observers'. But this claim to privilege is misleading, since probabilistic arguments suggest millions of habitats suitable for life in the universe (some details are in Sagan). What may be justified is somthing more like this: we are favoured in that the physical conditions for our existence, as observers, are met. In this we humans are hardly unique (though we're working at it); even on Terra much of the rest of the animal kingdom is similarly favoured. And still much more than a weak selection principle need require is dragged in. It is enough, for selection, that this universe contains places, in fact like the earth, in the neighbourhood of long-lived stars where heavy metals occur, and so on (for certain other purely geological features).

Boltzmann's explanation of the present high degree of cosmic organisation which is extremely improbable (in a thermodynamical setting) is also said to apply a 'weak anthropic principle'; 'the only reason that we are privileged to witness this exceedingly unlikely occurrence is that our very existence [etc.] depends upon the condition which alone can be established by that remarkable fluctuation' (D p. 128). But again only gross physical organisational principles are selected for; and no more than a weak *selection* principle is required.

Several coincidences cannot be "explained", so Carter and Davies claim, simply by a weak principle (at least in the absence of multi-universes). For these appeal is made to the *strong* (or better *global*) principle: 'The universe must be such as to admit the creation of observers within it at some stage', in Carter's formulation (p. 120). A corollary of the strong principle in this heavily necessitated guise is that observers are conditionally necessary; they must exist given the universe does. And since observers may very easily never have evolved in the universe, this is manifestly false. So, for different reasons, is the appalling Cartesian paraphrase Carter gives of the strong principle, 'cogito ergo mundus talis est'. The world would presumably not be so very different were the contingent premiss false; and certainly the premiss may be true but the conclusion false. But at least this paraphrase abandons the necessity loading, and gets the principle into inferential form, with the appropriate conclusion. For, properly formulated, the scheme is as before, ideally a lawlike conditional of basic form, if F then T, where however T is a genuinely global claim that the universe is such (e.g. the universe now contains more matter than radiation). The distinctive feature of the strong scheme, so recast then, is that T is holistic assertion about the universe, including essential reference to it, not, as it may be on the weak principle, about some local theoretical features of the universe, which can readily be stated or restated without reference to the universe. But the distinction is not particularly robust, nor is it from a world-selection perspective very important.

The trouble with Carter's extravagant Cartesian paraphrase of the strong principle is that it gives a most misleading impression of satisfactory antecedents for the scheme, and makes it presently impossible to argue in an appropriately lawlike way within requisite physical bounds to the intended consequent. For example, there is still no physically respectable route from (egocentric) thought to matter; and given Carter's proclivity to idealism (exhibited in C2)), he may well get stuck in the framework of idea — unlike Descartes without God to pull him out. Hard as it is to credit, Carter is excelled by Davies, who says of the strong principle that 'in essence it claims that the universe is tailor-made for habitation, and that both the laws of physics and the initial conditions obligingly arrange themselves in such a way that living organisms are subsequently assured of existence. [So it is] ... akin to traditional religious explanation of the world: that God made the world for mankind to inhabit.' (D p. 121). Such erroneous presentations have done much to encourage both a new anthropocentrism and the idea that anthropic explanations are secular products on a par with, and in competition with, design explanations. A duly reformulated strong schema supports none of the teleological claims Davies makes regarding the universe. Nor, as will appear, are "anthropic" explanations, when made presentable, akin to religious explanations of features of the world. The explanations take different logical forms and involve quite different ingredients.

To see what is really required for the strong schema to operate, it pays to look at applications. Then it becomes evident that observer-centric and biocentric considerations are strictly irrelevant. Once again *far* stronger, and more dubious, conditions than are required for the estimates actually made have been introduced. For instance, according to Carter, his condition (8), which imposes an order of magnitude upper bound on cosmological (Boltzmann) constant κ, 'is a good example of a prediction based on what may be termed the "*strong" anthropic principle*' (C p. 294); (8) is as follows:

$$\kappa \lesssim \left(\frac{\eta^2}{m_p} \right)^{1/3} m_p^{\,3}.$$

But all that is involved in obtaining this bound, of relevance, is the assumption that 'the universe is not radiation dominated all its [finite] life (i.e. that the matter contribution ... to the mean mass density becomes greater at some stage than the radiation contribution ...)' (C pp. 293-4). Insofar as this is necessary at all — since the estimates concern only very broad features, and not local variations — it is as necessary for lichen as for larkspurs. All that is required is a slightly stronger world selection principle than merely that the world contain heavier elements at some stage; but still only a geophysical principle. And this is *all* strength amounts to here. The same set of points applies to Carter's further use of the strong principle, to estimate the lower bound on κ, which applies 'the conventional hypothesis that galaxies are formed by condensation, starting as relatively small density fluctuations in an otherwise homogeneous background' (C p. 294). The further tendentious assumption in this application is that galaxies are 'necessary for the formation of stars and hence of life' (C p. 294).

Nonetheless there are arguments for the strong principle, though fallacious ones obviously. They come firstly from positivism. If the universe exists then it must be observable, so there must be observers. Davies (in his exposition of Barrow and others) then argues from the false premiss that only what is observed exists, that a 'universe which did not admit observers is meaningless' (D p. 121). This is idealistic garbage. They come secondly from an alleged explanatory role, in explaining coincidences. But it is unnecessary for this purpose as initial world selection will serve. They come thirdly from human chauvinism; thus, too human existence is said to be '*responsible* for the very special structure of the universe' (D p. 121). The connection is not however causal; so what is it supposed to be: teleological? There is thus a serious problem as to how this responsibility, hardly evident, is exercised. Finally a strong principle might be argued for on grounds of uniformity — one principle to cover all cases. But better a weaker correct principle than a strong false or dubious principle. And no doubt a weaker geophysical principle would suffice for all *physical* constants. (Of course, there remains the matter of *this* world selection. This world does exhibit life, does include humans, and so on. But these features, like the present species of eucalypts and whereabouts of grazing wombats, are not germane to the explanations, or relevant, and are abstracted from in selecting explanatory classes of worlds'.)[26]

Amusingly, astrological and stronger anthropic principles are converses of each other. According to *astrology,* celestial events influence human affairs; while under its *anthropic* analogue, human affairs influence celestial events. Celestial events and processes include those of the sun, moon and other planets (especially). And these certainly appear to have an (indirect) weak influence, especially through the solar atmosphere and large planetary plasmas, on terrestrial phenomena (Feyerabend, p. 93). The anthropic converse, in this form damagingly anthropocentric and exhibiting an excess of hubris, is *much* further from the truth.

Not just the anthropocentric, but the biological emphasis is misplaced. Despite Leslie's insistence, life is not essential in many worlds' explanation of numerical features. And despite the biological analogies, selection is not just like natural selection. It is not selection *for*, for fitness, survival, or whatever. Nor, more important is it selection *by*, by some agent. As there are values without valuers, so even more, there is selection without selectors. Although selection is sometimes accomplished through selectors, often selection takes place without selectors, randomly or otherwise — this time as in natural

26. Davies also suggests that many-worlds theory can provide a plausible physical (as opposed to philosophical) justification for the strong principle (D p.122 middle). In fact he never really shows this satisfactorily (nor can it be so shown), and in pointing to the power of the many-universe theory he undermines the strong principle, showing it otiose.

selection, which does not require a personified Nature to do the selecting, as evolutionary theories have emphasised. Such *explanation can straightforwardly avoid agency*. In avoiding agency, selection *is* like that of Darwinian evolutionary theory; and *selection* contrasts with *direction* as included in alternative evolutionary accounts (cf. Darlington, p.14ff).

Though anthropic principles come in a variety of forms, depending upon how the conditional schema involved is filled out, none of them, then, does what is usually said, none depends essentially on the presence of humans, or of life. Syntactically, they elaboratestatus quo arguments, of form L), with factual first premiss F concerning the state of the world, locally (weak form) or as a whole (strong form).[27] Semantically, the factual premisses function as *world selection* principles; they serve to mark out the class of physical worlds or to narrow them down to these or those, e.g. to those where heavier elements such as carbon occur, those where long-lived stars, such as the sun, appear. It is true that carbon is sometimes taken to provide an "order-of-magnitude" approximation for life (that is the nearest to humans that the "approximations" get); a long-lived star is supposed to provide the steady warmth required for the evolution of life (but long-lived stars, water, and heavier objects are as near to life as the arguments need get). But these additional, and more dubious, details

27. Often status quo arguments are presented in modal form, with the connecting scheme set in either necessitated form, if F then necessarily (it must be that) T (e.g. if there exist so and so, then the universe must have, or conform to, such and such features), or, in quasi-transcendental form, F is only possible if T (e.g. what is the case locally (what observers observe, etc.) is only possible if physics is such and such). It seems that these modalities are de dicto and that the claims involved can be adequately represented, as usual, through a necessitated connecting schema, Necessarily, if F then T. The modality involved is not one of logical necessity, or even always one of nomic strength, but reads rather 'It is more than merely contingent that' in lowest common denominator form. To attach the (relative) modality simply to consequent T would be an error. The argument does not guarantee the conclusion, Necessarily T, nor does it pretend to do so. The second form is a little more problematic; but it appears to assert that F is inconsistent with not-T, and so, through obvious connections, the same as the rectified first form.

are unnecessary for the main thrust of status quo arguments, as distinct from their anthropic and biocentric argumentations.

Given that the worlds selected are of this and that cast — in general meet gross geophysical constraints — other features of them can be derived (more or less, up to the rough standards accepted in physics) and explained, in particular, how and that it is that certain (fundamental) physical constants lie in restricted ranges, narrow and unexpected ranges. These arguments, duly filled out, *do* provide explanations, non-causal explanations, of physical features of a merely contingent, most improbable universe. Much there is, however, in these claims, that has been contested, from the psychological inadequacy of such a universe to the worth of such explanations, if explanations they are at all.

§5. *Problems with and objections to the cosmo-logical synthesis; and finding comfort in an unlikely, merely contingent, universe.*

Somehow contingent universes have acquired the reputation of being cold, remote and uncaring — not a fit habitat for sensitive creatures. But the reputation is undeserved, since contingency does not bear on any of these things. What is contingent can be hot just as well as cold or neither; caring or not, so far as the application makes sense at all; and so on. One can be warm and comfortable in bed on a wet and wintry night. One can be at home, comfortable in, in tune with, a tiny part of an improbable universe, as some tribal peoples are. None of these virtues are in any way assured by the quite separate matter of a necessary universe.

Furthermore, there can be, or have evolved, 'a degree of harmony between us and our surroundings', without such exaggerated claims, based on anthropic principles, as that 'our surroundings are very special and tuned to us' or, worse, that the universe is 'made for us'. We humans can be in tune with the universe without having the universe tuned to us, as we can follow and ornament a song on the wind or in the woods. But so far, especially recently, we humans collectively are not doing too well in attuning ourselves to the world.

As this illustration begins to reveal, metaphysical and psychological predelictions may play a not inconsiderable role in choice of physical theory, especially of controversial theories such as quantum theory and cosmological theory. In the case of such theories there is a certain bag of technical tricks, equations and so on, which are de rigeur — a theory-*skeleton* so to say[28] — and beyond that both an interpretation and setting for the bag of tricks, integrating them and supplying them with some sort of meaning, and usually also some further formalism connecting the tricks together or to a wider theoretical background. For example, even in accounts of quantum theory where too much in the way of interpretation is commonly frowned upon, extensive correspondence rules linking the formalism with classical physics are relied upon heavily. At least for everything beyond the theory-skeleton, which is what is applied in most concrete day-to-day applications of the theory, there is much room for rival flushing out of the skeleton — latitude such as there is in archeological reconstructions of peoples from some scattered bones.

Recasting quantum theory, as in the many worlds interpretation, offers not merely a basis for fleshing out the theory non-idealistically, but as well as for combining it with general relativity. However such recasting, when not ignored (the common fate of nonstandard theories), is subject to much criticism. Happily most of the criticism, much of it directed more broadly at plural world theories in general, misses the neutral modification. There are firstly a batch of aesthetic and ontological objections. These commonly take off from the unattractiveness of such profligate duplication or replication of worlds. Well tastes and values, like intuitions, do vary with subculture. Some of us, who escaped over-exposure to the Reality Principle, do find a neutral worlds pictures attractive, indeed very inviting. So, next, the whole thing is said to be unbelievable: no one can reasonably believe in (the existence of) these un-limited numbers of universes. Granted, we do not believe in this either. These other worlds do not exist; but we can make use of these worlds nonetheless, especially in explanation. In this way we avoid a heavy load of objections carrying on about excess ontic baggage. We also short-circuit main criticisms based on Occam's razor. (All these objections are met, in much detail, in JB).

Linked to such Occamist protests are a batch of objections to the effect that worlds pictures are *over-engineered*, both too complex and

28. What we have are fragments of theories, rules of thumb, and calculating devices, that appear to work in a range of cases. It is these parts that may generate successful technology. The picture is like engineering.

including too much baggage. For instance in thermodynamics a small fluctuation producing some order is more likely than one producing lots of order, one galaxy more likely than many. Why similarly do we not find ourselves in a one galaxy universe, which is far more likely? The answer is in part: because less likely contingencies can well hold. Is then 'the ubiquity of observed galaxies in *our* universe ... therefore a mystery' (D p. 129)? No, such numbers can, like others be explained. For instance, the evolution of just one of a thing is itself very unlikely. And there may be further special reasons. Thus Dicke and Peebles remark, in commenting on the "overdesign" of the universe for a few conscious individuals that a single galaxy cosmos might be ruled out by Mach's principle. Moreover, the approaches revealed in these questions and remarks are based on various unwarranted presuppositions. The "overdesign" idea, for instance, presupposes that the universe was set up *for* some individuals; but the worlds picture correctly avoids this assumption. The things in this world happen to be there, probable or not, and often, for reasons we can sometimes explain, not. But there is little solid evidence that they are arranged, for us or others.

In its original form the "overdesign" objection was mainly directed at principles like the anthropic, as are a batch of objections from unverifiability and unfalsifiability. The well-worn criticism, that notorious psychoanalytic and marxist principles did too much, being so designed that they covered every case, was redirected against anthropic principles. It is protested that 'it is hard to see how the anthropic principle can be used to make testable predictions, because any theory inconsistent with our existence is manifestly false'. Not only have such protests been weakened by avant garde philosophy of science, but, as Carter has pointed out, anthropic arguments could in principle have been used to predict various numerical coincidences before they were noticed. And the assumptions of anthropic arguments do admit of falsification, e.g. where erroneous coincidences are derived (though it is unlikely that the factual premiss of weaker forms would be abandoned, other assumptions would be surrendered first). As regards world-synthesis, verifiability objections are largely misdirected, because what are at issue are not physical principles, but under object-theory conversion, themes of semantics, of interpretation. Granted verifiability objections *do* have some force against many worlds theories, whether in physics or semantics, which assume that all the worlds involved exist, by virtue of what is meant by *existing*. But the force of these objections is neutralised by neutral worlds theory.

Often, as with verificationist objections, the criticisms of manyworld cosmologies and of selection principles such as anthropic or geophysical principles are intertwined, and disentangling the criticisms is enough to partly deflate them. So it is also with the related charge that the worlds-selection theory is unscientific or at least dubiously scientific.[29] Plainly much turns on what is admitted into that esteemed category, *scientific*. But on most accounts, use of selection principles succeeds in getting in. And so, though less decisively, does many worlds quantum theory. After all, it has approximately the same sorts of predicative and test capabilities as more orthodox quantum theory. That fact of narrow empirical indistinguishability may be the source of other complaints, but it gives no ground for the charge at hand. But surely *world* selection principles are excluded! It is true that some theoretical physicists, and many philosophers, losing sight of what enters into the fuller range of scientific theorising and experimenting and wanting to stick to a narrow hypothetico-deductive methodology, are uneasy with worlds and their selection, and would prefer (per impossible) ultimate unified theory explanations. No doubt such semantical apparatus does fall foul of the hypothetico-deductive views: that simply reveals further serious defects in such views. But to reach the substance of the charge, consider some of the criteria often set down for being scientific. Unfalsifiable? Surely not in areas where the framework is pinned down by physical theory. Overcomplicated and insufficiently simple? Not given what the worlds theory is intended to accomplish semantically (e.g. the theoretical work it is also put to in areas such as linguistics). Etc., etc.

Perhaps the most telling objections against status quo arguments, and theories like world-syntheses which include them, concern their

29. A main charge made by Leslie against many-world cosmologies, e.g. L1, p.148ff. It is a surprising turn, given the popularity of hypothetico-deductive methodology, to have it also objected that many-world theory voids induction 'Putting chance in control of inter-world differences erodes confidence in our sample of Reality, on which our inductions are based' (L1, p.149). Insofar as this objection gets off the ground (it is not transparently clear that it does), it depends on assuming the reality of the entire-world ensemble. So it lapses against a neutral theory.

explanatory capacity. Strangely they have been condemned both as explaining too much — any thing at all can be brought out in some world — and as explaining too little and being trivial. Not both these objections are likely to succeed, as they tend to undercut one another. Independently, it seems clear that the arguments involved *do* provide explanations, for instance, of the strength of the strong nuclear force. It also seems clear that the explanations afforded are of varying depth, this depending in part on the depth of the underlying physical theory involved, and the plausibility of the further assumptions made in the argument.

Better exemplifications of status quo arguments in physics satisfy not only more ordinary requirements for explanation; they also meet the more demanding conditions assembled by Hempel, conditions which represented, for some considerable time, the mainstream position on what counted as a scientific explanation. Furthermore, the chief objections to the Hempelian account that have emerged have been to the effect that it is too rigorous, not that it fails to provide jointly sufficient conditions for explanation, it is enough then to show that Hempel's conditions on 'the basic pattern of scientific explanation' (p. 247ff) have been met. By contrast with design arguments, the logical conditions of adequacy are satisfied. The explanandum T is a logical consequence of the physical argument elaborating the schemas F, if F then T; the explanans has empirical content, at least in the shape of premiss F; and the explanans contains general laws which are actually used in the derivation. For, in better status quo arguments, the conditional schema, if F then T, provides a lawlike connection which follows from arguments using physical laws. Finally, the demanding empirical condition of adequacy, that the premisses used in the explanans are true, is satisfied in better status quo arguments.

Were the basic pattern also necessary for scientific explanation, it would be an easy corollary that many poorer status quo arguments fail to provide such explanations (beginning with Carter's and Descartes' *Cogito* arguments), and that there is much that status quo arguments cannot presently explain decently, including such major puzzles as life and intelligence in the local world. It can be independently argued, moreover, that poorer status quo arguments, which fall patently short of meeting Hempelian conditions, fail to generate satisfactory (or satisfying) explanations. Trivial, dogmatic forms, such as that things are the way they are because that is the way they are, represent a virtually worst case of this sort. But scarcely better, or more informative, are those arguments which apply the possibility weakening principle, that what is so is also possible. Such, slightly embroidered, are arguments with connecting principles like "The universe is inhabitable, because we are here, because humans inhabit the earth", "The universe is suited to intelligent life because there are people to ask such questions" (examples adapted from the sorts of anthropic arguments Forrest focusses upon). These arguments, which offer almost immediate inferences, fall patently short; they involve no further appropriate argumentation making use of general laws.

Given that better status quo arguments do afford basic (Hempelian) scientific explanations, and given further that the arguments do serve to remove genuine puzzlement and are not without predictive force, why have they been faulted as explanations, and sometimes criticised as not providing explanations at all (e.g. Forrest)? The main reason offered, that these "explanations" are "back-to-front", appears to rest on the assumption that all genuine explanation should be broadly casual, and accordingly exhibit the (time-) direction of causation or control. Status quo explanations are certainly not causal, and may well run counter to causal direction, explaining features of the early universe through the present distribution of elements. That is, however, perfectly in order. For satisfactory explanation is not causally restricted either ordinarily or scientifically. Hempel supplies several different sorts of examples of his basic pattern of scientific explanation which are not causal explanation or causally or control directed (pp. 352-3). Especially striking in this regard is his straightforward optical example of 'a particular event...satisfactorily explained by reference to subsequent occurrences'; but his example of two-way explanation, where the period of a pendulum serves to explain the length of the pendulum as well as conversely, is also highly relevant.

For it is too commonly assumed that numerical coincidences should be explaining the presence of water, carbon and the like in the universe, *not* vice versa. But there is no reason why the explanation should not run in the illuminating status quo direction instead of, as well as, vice versa. That illuminating direction is after all from the familiar to the much less familiar, and more in need of explanation. It is true of course that the more familiar, such as the presence of water and carbon, also calls for explanation; but that simply means that status quo explanations are, like most explanations, not ultimate: they begin in the middle way. Nor do they, except in special, rather ad hominem style of status quo explanation, unreasonably stop the legitimate quest for further and deeper explanation. The explanation-stopping forms are those (which Forrest discusses) where the response to a request for explanation takes the contraposed form; if it weren't so you wouldn't be here to ask the question. However such put-downs (in the envisaged contexts) would not deter persistent inquirers for very long. They would be off and away in search of further explanations, such as better status quo arguments may furnish (at least for the time being).

The more damaging charge, then, is that world-synthesis can explain too much. The charge is backed up by the following sort of consideration. Take any puzzling feature of the universe, PF. Then it can be explained simply by selecting worlds where PF holds. But the charge misrepresents world-synthesis theory. There is *more* to it than this. There is a crucial argumentative linkage also involved, between PF and gross geophysical features of the worlds (near factual world T) which are selected. Or, put differently, the selection does not take place *on* the basis of PF, but (merely) under the constraint of gross geophysical features; accordingly if the argumentative linkage from satisfactory status quo arguments is missing, PF is *not* to be explained through world-synthesis. In short, then, world-synthesis theory offers explanations *when* the framework is suitably fleshed out by physical theory; and then the explanations may vary greatly in quality depending on the depth of the physical information involved in the argumentative linkage.

Essentially the same points undermine Forrest's further objection to such many-worlds explanation, 'that it "explains" contingent falsehoods as easily as contingent truths; all we have to do is to *posit* suitably many and varied worlds' (p. 9). thus the theory is alleged to explain the turning of pumpkins into coaches as easily as numerical coincidences. But there is no such free selection of *physical* worlds — which do not include worlds validating arbitrary magical transformations and practices. Status quo explanations may not be easy at all, but physically complex, they are not always and easily available, and they can fail, as when an assumption involved in the elaboration of the connecting schema fails[30], and the argumentative

30. A related philosophically important example where the schema does

schema issues in a contingent falsehood. For a necessary condition that a status quo explanation be successful is that the argument be correct; but then given that the argument form is valid, the conclusion cannot be simply false.

It is in conforming to such conditions of adequacy as deductive validity that satisfactory status quo explanations differ decisively from design explanations, explanations which are sometimes seen as on an explanatory level with and in winning competition with status quo explanations and their plural-world setting (thus e.g. Leslie), and sometimes even confused with them. Design arguments characteristically take the deductively invalid abductive modus tollens form:

Things are surprisingly so and so	F
If a design hypothesis held (e.g. the universe anticipated observers, a design-force operated), things would be (unsurprisingly) so and so.	if H then F
Therefore, a design hypothesis (probably) holds.	H

Nor in design arguments is the connecting schema normally elaborated by appropriate scientific argument; nor, where God is invoked, is there any way of suitably confining the argument scientifically.

Thus the first of Leslie's larger claims is false: — 'Science does not support the World Ensemble hypothesis *rather than* the God hypothesis. We do not have...strong evidence of an Ensemble' (L1, p. 150). 'No branch of physics calls for their existence in a way commanding wide acceptance' (L1, p. 53). The main reason is that the God hypothesis is not part of a physical theory in the way that many-world theory is of quantum theory (thus, e.g., there is no *physics* text corresponding to DeWitt and Graham for the God hypothesis). While the last claim is true, it does not tell against the truth of neutral many-worlds theory. What science supports is science, not the metaphysics it presupposes. Physics is not however all of science by

so far fail is in Moore's proof of an external world, noted above. The reason is that the existence of arbitrary material objects, such as hands or isolated cabbages, does not guarantee that the requirements (order, unity, coherence, mind-independence, etc.) for an *external world* are satisfied.

any means, and even science doesn't do everything, only a rather narrow selection of things.[31]

APPENDIX 1. Some Ancient Antecedents

> The Non-Limited is the original material of existing things; further the source from which existing things derive their existence is also that to which they return at their destruction, according to necessity (for reparation)...

So, in the 6th Century B.C., said Anaximander, perhaps among the first also to set down a story of the evolution of humankind.[32] Something the same was said in the text, though on the favoured tale a Heideggerean and Taoist touch was lent, with Nothingness replacing the Non-Limited. In the beginning, on this story, there was nothing; and ultimately, too, there will be nothing. Reparation will have been paid.

The parallel with Anaximander can be pressed further. In the contemporary accounts of origins, oppositely charged pairs of particles are created in the process of pair formation from the vacuum; while in Anaximander's story of the formation of world order, 'the opposites which are present in the one (the Non-Limited), are separated out from it' (but 'the "opposites" are the hot, the cold, the dry, the moist, and the rest': see Robinson p. 25). There is also a phenomenon which corresponds to some limited extent to the Big Bang, namely the Vortex.

It seems clear, however, from the material Burnet assembles, that Anaximander's position amounted to the first less satisfactory resolution, matter or substance always. For the Boundless or Infinite was a material cause, a *substance* (p. 52); it is 'eternal and ageless' and 'encompasses all worlds' — which makes it a queer "substance". Also there is in it eternal motion, in which is brought about the origin of the worlds. Further, according to Simplicius, 'he did not ascribe the origin of things to any

31. An earlier version of this paper was presented at the Australasian Association of Philosophy Conference, August 1984. The helpful comments by David Armstrong, Brian Ellis and David Lewis, unreferenced above, were made during the discussion. Both John Leslie and Jack Smart supplied me with worthwhile commentaries; several of their points have been incorporated, but some have been resisted. The initial version was published in an Australian National University preprint series.

32. See Freeman, p.19. for fuller discussion of Anaximander's position; on the need for reparation, see Burnet.

alteration of matter, but said that the oppositions in the substratum which was a boundless body, were separated out'. If that is right — and it may not be, especially given later ontological influences (cf. p. 61) — then the matter *is* clear.

'Anamixander believed there were' "innumerable worlds in the Boundless" (p. 58). These worlds were concurrent, not successive. Whether they were *coexistent* remains unclear, but later (biassed) tradition took them all to exist, making Anaximander's position a many-existent-worlds theory.

The law of compensation, under which for borrowing or variation reparation must be made, becomes the law of conservation. The reparation parallels the repayment of "borrowed" mass-energy. The more general steering of all things — overarching order in natural processes — becomes the laws of nature which govern (regulate) the processes. 'The orderliness...is grounded in the nature of things as such'.

Anaximander's account represents an immensely important stage in the transition from myth to science. ...'Hesiod's account of the origin of the world-order is from first to last anthropomorphic. Anaximander's account represents, in principle, a complete break with this mode of thought' (Robinson p. 27). From this angle the anthropic and idealistic fixes of contemporary science show marked regression.

That transition, beyond anthropic creation stories, is also accomplished in Taoism, where the main philosophical essentials of the favoured resolution can be found. Something flowed from nothing, in a seemingly paradoxical way, but not through any creation or agency. There was a time before the beginning when nothing at all existed. The problem of laws (of nature) was also recognised, and resolved. Laws did not exist (independently at least of things that did) but were exhibited in things that did exist. So it seems to follow that, at the stage at which nothing existed, the laws could hold without having any sort of existence, i.e. truth and existence were duly separated, and ascriptions of existence properly restricted to what does exist. (Fuller details of Taoist cosmology, under this type of interpretation, are ventured in 'Taoism and deep ecology', written with D. Bennett.)

What was mainly lacking in cosmogonic tales, then, from the 4th C. B.C. until the 20th C., was a plausible explanatory story as to how something could come from nothing. Such a story a few humans are just beginning to piece together.

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