This is a draft. The final version will appear in *Synthese*

An Unwelcome Consequence of the Multiverse Thesis

ABSTRACT: The Multiverse Thesis is a proposed solution to the Grandfather Paradox. It is popular and well promulgated, found in fiction, philosophy and (most importantly) physics. I first offer a short explanation on behalf of its advocates as to why it qualifies as a theory of time travel (as opposed to mere 'universe hopping'). Then I argue that the thesis nevertheless has an unwelcome consequence: that extended objects cannot travel in time. Whilst this does not demonstrate that the Multiverse Thesis is false, the consequence should give pause for concern. Even if it does not lead one to reject the thesis, I briefly detail some reasons to think it is interesting nonetheless.

1. Introduction

The problem of the Grandfather Paradox is that if time travel were possible a time traveller could kill his paternal grandfather before the birth of his own father. But that is *im*possible, for if the traveller carried out the murder then his father would never be born, thus nor would the traveller, so he would not be able to go back in time to kill his grandfather in the first place. Hence we apparently have a contradiction.

There are two popular responses to the Grandfather Paradox, the first is from David Lewis [1976] and the second is the 'Multiverse Thesis'. In this paper I concentrate solely on the Multiverse Thesis and demonstrate that it has a significant, and unwelcome, consequence: that extended objects cannot travel in time. A similar thesis has been argued for by Allen Everett [2004], specifically that in the case of Deutsch's version of the Multiverse Thesis the theory of decoherence indicates that time travelling objects must be broken into microscopic fragments. Here I intend to demonstrate that this result is not peculiar to Deutsch's version of the Multiverse Thesis, and is a problem for any theory that endorses that thesis. Moreover, the reasons used to establish that extended objects cannot travel through time are, unlike Everett's, philosophical rather than quantum physical.

2. The Multiverse Thesis Examined

The thesis is:

> **Multiverse Thesis:** If, at time t', x time travels to some prior instant, t, then x arrives at t but in an alternative universe, distinct from the one x was previously in.

The Multiverse Thesis allegedly solves the Grandfather Paradox. When the time traveller goes back in time and kills his grandfather, he arrives in a separate universe. Whilst it is the case that *in that universe* his grandfather is killed, there is no paradox for it is still the case that in the original universe his grandfather lives to father his father, who in turn fathers him.

The Multiverse Thesis is popular. Like many theories of time travel it has appeared in fiction.[1] It has also been endorsed by philosophers [Abbruzzese 2001]. However, most importantly, it is held by some contemporary physicists [Deutsch and Lockwood 1994] who argue that we should account for time travel using quantum computation, and that when we interpret this using the Everett interpretation it turns out that the Multiverse Thesis is true [Deustch 1991: 3206]. Indeed, in many books on popular science the Multiverse Thesis (showcased in the form of Deutsch and Lockwood's theory) is either the proposed answer to the Grandfather Paradox [Greene 2004: 455-8; Gribbin 1992: 202], or at least examined as a plausible, live, option [Davies 1995: 251]. So the Multiverse Thesis is an important position in both the philosophy and physics of time travel.

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[1] For instance, in novels such as David Gerrold's *The Man Who Folded Himself*, Stephen Baxter's *The Time Ships*, Michael Crichton's *Timeline*, and films such as *Primer*. It has also influenced other fiction such as *Star Trek* and *Back to the Future*, where on some occasions time travel takes travellers to a different universe (although on others it does not – depending upon the needs of the plot).

3. Universe Hopping and Appropriate Connections

But there is an objection to the Multiverse Thesis: that it isn't proper time travel at all, for you end up not in your own past but in the past of some doppelgänger universe [Hewett 1994; Richmond 2003: 303-4]. So the objection goes, the universe that a time traveller arrives at is not their universe, and the 'past' they arrive at is no more their past than an intricate, well-staged, mock-up of the past would qualify as being so. So whilst I end up in a universe where I could kill a man who *looks* like my grandfather, he is a mere doppelgänger – for all intents and purposes I may as well have stayed at home and just created a simulacrum of my grandfather to kill instead. The objection concludes that what you have is not a time machine but a fantastic device that either generates doppelgänger universes, or navigates the already existing multiverse. Call this the Universe Hopping objection. I believe that there is a plausible response to the Universe Hopping objection, and it is expedient for me to detail that response (although don't get too hung up on the details, I claim only that this response is defensible, not that it is flawless).

First, in order to help clarify the objection, stipulate the following definitions: call the universe I travel *from* 'universe α'; call the universe I travel *to* 'universe β'; call the time I travel *to* the *target time*; say also that the target time I arrive at 'qualifies as the past' if it is *appropriately connected* to the target time in α; similarly for the *contents* of β (so my grandfather in β is 'the past version of my grandfather' iff he is appropriately connected to my grandfather from α). We can now restate the problem: if the target time a time traveller arrives at in β is not appropriately connected to the target time in α (and, similarly, the contents of β at the target time are not appropriately connected to the contents of α) then this is merely universe hopping and not time travel. Therefore, the proponent of the Multiverse Thesis must demonstrate that the target time in β is appropriately connected to the target time in α (similarly for the contents).

One way for things to be appropriately connected is by (numerical) identity. If my grandfather in β was identical to my grandfather in α then clearly they would be appropriately connected. If they were identical then *of course* my grandfather in β would be a past version of my grandfather in α. However, it is equally clear though that my grandfather in β is *not* identical to my grandfather in α (for one was murdered and the other was not) so numerical identity won't do in this case. Fortunately for the Multiverse Thesis, identity is not the *only* way for things to be appropriately connected. Consider cases of fission, where one object splits into two (such as an amoeba dividing, or the Ship of Theseus). Call the initial object the *parent object* and call the post-fission objects *fission counterparts*. Intuitively the fission counterparts were both once the parent object.[2] So the fission counterparts are distinct,[3] but remain appropriately connected. For instance, if you wanted to punish a criminal who committed a crime at *t*, but who fissioned at a later time, *t'*, you'd be well within your rights to punish either (or both!) of his fission counterparts. This is permissible because the fission counterparts (i.e. the criminals after fission) are appropriately related to the parent object (i.e. the man who committed the heinous crimes). So in fission cases there *can* be two things that are distinct but which are nevertheless appropriately related.

So one way for target times to be appropriately connected is for universes to be fissioning objects. When a time traveller goes back to target time *t* they cause the universe to fission,

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[2] I would have a problem if you didn't believe that, in some sense, the fission counterparts were once the parent object. But assuming that they were is not overly contentious, nor is it a marginal position, and I am more than happy for what I say here to be conditional on such a belief. Given that I am arguing *against* the Multiverse Thesis, you should accept that the fission counterparts were once the parent object, if only for the sake of charity.

[3] Alternatively, if you say they *are* identical then all the better. Below I treat universes, and their contents, as fissioning objects so if fission counterparts are identical then the bifurcating universes *would* be identical (and, thus, obviously appropriately connected). I still think that'd be weird, as one counterpart would be F and another counterpart ~F, thus numerically one and the same thing would be both F&~F, but that's a problem for anyone who thinks fission counterparts are identical, not me.

such that α and β (and their contents) share every temporal part until *t*. From *t* onwards, they stop sharing temporal parts and fission into two. They are distinct, but are fission counterparts, and so can be treated the same as the fissioning criminal. The target time I arrive at in β is a fission counterpart of the target time in α (similarly for the contents of α and β that exist at the target time), and are thus appropriately connected. Just as it is good enough to imprison a fission counterpart of the criminal, if you want to travel back to 1955 it is good enough for you to travel to a fission counterpart of 1955, and if you want to kill your grandfather then it is good enough to kill one of his fission counterparts (and so on and so forth).

That is one way for appropriate connection to be cashed out – wherein the multiverse is a 'branching' multiverse, and all of the universes mereologically overlap up until the point that their histories differ. However, there are alternatives, such as 'diverging' multiverses where there are lots of distinct non-overlapping universes, qualitatively identical up until the point that their histories differ. Such an alternative view of the multiverse will demand an alternative way to cash out 'appropriate connection'. Deutsch and Lockwood suggest just such a thing: two times are appropriately connected if and only if they are qualitatively identical with respect to their physical properties [Deutsch and Lockwood 1994*b*; Deutsch 1997]. I believe this second explanation is inferior, for it encounters problems given the possibility of an eternal, yet contingently unchanging, universe. Given this analysis of appropriate connection, all the times in such a universe – in being qualitatively identical to one another – would be appropriately connected. But then they all count as being the same time, for that's what appropriate connection amounts to: if *t* and *t*' are appropriately connected then *t* and *t*' are the same time as one another (even if those instants aren't numerically identical – in the same sense that an individual may not be numerically identical to my grandfather but is still the 'same grandfather' as him in some appropriate sense).[4] So, every instant in that universe counts as being the same instant as every other (entailing that the universe is instantaneous) which is *ex hypothesi* false for it is eternal. However, feel free to use it instead if so desired. Indeed, use whatever explanation of appropriate connection you care for and see how well it fares in light of what I say. I contend that any (plausible) explanation of how things turn out to be appropriately connected will still commit the Multiverse Thesis to the problem given in §4 (and that's all I'm using it for during the course of this paper).

So, for the sake of argument assume that there is some way, such as either of those above, to cash out appropriate connection and, with that in place, avoid the Universe Hopping objection. With this in place I can now demonstrate the unwelcome consequence of the Multiverse Thesis.

4. The Super Hindu Scenario

Imagine that Hank, a veteran time traveller from the year 1889 AD, travels in time to the year 1000 BC. Here he encounters the early precursors of the Vedic civilisation, and teaches them everything he knows about science, mathematics, engineering etc. Consequently, three millennia of discovery are skipped over in just a few years. By the year 2007 AD the world is a technological utopia inhabited by the descendants of the Vedics. Call them the Super Hindus. Given the radical changes early on, history ends up being very different (e.g. no World Wars, no British Empire, no polluting Industrial Revolution etc.) for it is inconceivably unlikely that history would play out even remotely similar given the radical changes that Hank has made.

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[4] Is it odd that numerically different things can be the same instant as one another (or the same grandfather etc.)? I think not, and think we should treat it in the same fashion that the Lewis's do when discussing holes [1970] whereby two numerically distinct entities can nonetheless 'be the same hole as one another'. In any case, this oddity is meant to be something we should *charitably* accept on behalf of the proponent of the multiverse hypothesis in order to avoid the Universe Hopping objection and make their theory work.

To explain this, proponents of the Multiverse Thesis will say Hank leaves universe α in the year 1889 AD (a universe *not* inhabited by Super Hindus), and travels to universe β whereupon he affects history in that universe (making it a universe that *is* inhabited by Super Hindus). But universe β is not just some random universe, as α and β are appropriately connected (say by overlapping up until the target time that Hank arrives at during the year 1000 BC). Hank has time travelled, then, for the time he arrives at is appropriately connected to the time he left. So far, so good.

Next, imagine Marty, who originates from the same universe as Hank (universe α), and is a time traveller. Marty travels to the year 1955 with the firm intention of killing his grandfather. According to the Multiverse Thesis he arrives not in α, but in some other universe. Yet nothing stated thus far indicates *what* universe he ends up in *except* that that universe must be distinct from the one that he left. Assuming Marty doesn't end up in some random universe (because then it really *would* be universe hopping) there are two (sensible) options.

Option one: Marty ends up in universe β, like Hank.

Option two: Marty ends up in some new universe, γ (where γ is a fission counterpart of α, in that it overlaps every temporal part of α up until the target time that Marty goes to i.e. 1955).

When Marty travels to 1955, given option one he ends up in a universe inhabited by the Super Hindus, the history of which has no relation to that of the world he just left (well, past 1000 BC at any rate). In β there is very little that Marty recognizes, for the world is inhabited by a peaceful utopian society, and the grandfather he intends to assassinate was never even born in β. It is clear that in this case Marty has not travelled in time, at least not in a sense that avoids the Universe Hopping objection, as the target time he arrives at is *not* appropriately connected to the corresponding target time in α. To demonstrate that it is not appropriately connected consider the first of the above theories of what appropriate connection may be. Marty *doesn't* end up in a universe that shares all the temporal parts of α up until the target time of 1955, but instead ends up in a world that only shares temporal parts with α up until 1000 BC. Thus if we are explaining 'appropriate connection' in terms of sharing temporal parts up until the target time, the two universes aren't appropriately connected. If, alternatively, we are imagining that appropriate connection is about being a qualitative duplicate with respect to physical properties then whilst Hank managed to travel in time (for the target time he arrived at *was* qualitatively identical to 1000 BC from α) Marty again fails to. The region of spacetime Marty ends up in has radically different physical properties than the region of spacetime from α that is 1955 (for it's occupied by Super Hindus). So if you use the second treatment of appropriate connection, this again does not count as time travel. (At this juncture, if you believe a different explanation of appropriate connection is called for, deploy it and see how it fares. I believe that any plausible explanation will entail that the target time Marty arrives at is not appropriately connected to that of the universe he has just left).

That it doesn't count as time travel also makes intuitive sense. If I said I'd take you back to 1955, and we ended up in a universe which had been inhabited by the Super Hindus for a few thousand years, then you'd rightly accuse me of not traveling in time at all. It could not be 1955 for there would be no Eisenhower or Churchill, no Albert Einstein, no president of Panama getting assassinated etc. None of the things that are meant to be in 1955 would be there. Whilst a fantastic task would have been achieved, it would not qualify as time travel.

One could dig their heels in. We might say that this *is* time travel. That is, one universe's 1955 may be one way (with Eisenhower as president) and another universe's 1955 may be a totally different way (with Adlai Stevenson as president, or even bigger changes such as a Manchurian candidate being president, or no president at all as only cockroaches roam the earth) but they're *both* connected by the simultaneity relation and both count as being 1955 (just as, in our own universe, Paris in 1955 was very different from the surface of the moon in 1955, but they both qualified as being simultaneous with one another). Given such a situation someone might turn stubborn: when you travel in time whilst you may not arrive in a universe anything like the one you left, but it's still the case that you've travelled back to 1955. But at best this is only a pyrrhic victory. It may *technically* count as time travel, in that the point in external time you arrive at is earlier than the one you left, but with no grandfather in sight, or anything that is vaguely recognisable, it does not seem that the multiverse hypothesis can salvage the possibilities we want to salvage – of travelling back and meeting people long past, of making right what once went wrong, or of bumping off one's paternal ancestors etc. Allowing for those possibilities was, I presume, the intention of introducing the multiverse hypothesis in the first place and it is exactly those possibilities now being denied to Marty. Hence option one is deeply unsatisfactory.

Presumably then, Marty *should* be able to travel in time *and* do so in such a way that he can meet his relatives, go back to cities from his own past etc. *and* for such travelling not to be precluded just because a different time traveller from his home universe has travelled to a target time earlier than the one he intends to arrive at. So we should drop option one, and instead pursue option two (which would, in any case, be Deutsch's chosen option). [5]

5. The Slicing Objection

Given option two Marty travels to a universe γ, distinct from both α and β, where γ shares temporal parts with α until 1955. That fixes the Super Hindu objection, but a new problem arises. Whilst the target times that Marty and Hank travel to are separated by an interval of 2,955 years, the extent of the interval is irrelevant. If two chrononauts go to two different target times then they both end up in two different universes *no matter what interval separates those target times* (be it millennia – as in the case of Hank and Marty – a century or a picosecond). The proof for this is simple. For purposes of *reductio* imagine that what I say is false, and so the following is true:

> **The Interval Hypothesis:** There is some interval *i* such that if (i) *x* travels to target time *t*, and (ii) *y* travels to target time *t*', and (iii) *t* and *t*' are not separated by an interval greater than *i*, then *x* and *y* travel to the same universe. Otherwise, *x* and *y* end up in distinct universes.

Stipulate that the interval is a mere five seconds. Now imagine that there are eighteen billion or so time travellers[6] such that the first traveller goes to a target time in 1000 BC, the second five seconds later, the third five seconds after that and so on and so forth, until we arrive at the eighteen billionth time traveller who is aiming for a target time in 1955. Given the Interval Hypothesis, since the target time of the second time traveller is within five seconds of the first, then they end up in the same universe as one another. Since the target time of the third time traveller is within five seconds of the target time of the second time traveller, the third time traveller ends up in the same universe as the second (which is to say that they both end up in the same universe as the first). Iterate this for all eighteen billion time travellers, and we can say that the eighteen billionth time traveller, who is travelling to 1955, ends up in the universe the first time traveller ended up in. *But this is the same scenario as that of Hank and Marty!* As that was meant to be the problem we were avoiding, by *reductio* the Interval Hypothesis must be false.

If the Interval Hypothesis is false, I believe we should endorse the following (below I consider, and will discard, supposed alternatives which are neither the Interval Hypothesis nor the Slicing Thesis):

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[5] For instance, Deutsch says that if I time travel to meet myself, the person I meet is initially qualitatively identical to me although 'Farther away in the multiverse there would be others who were already different from me at the outset of the experiment, *but a time machine would never cause me to meet those versions*' [Deutsch 1997: 308; emphasis mine]. So I take it that Deutsch means I could never time travel to a target time where the things at that time aren't qualitatively identical to the things from the original universe at that time *a fortiori* I can't time travel to the world of Super Hindus i.e. option one is false.

[6] Which is relatively feasible, for once time travel was introduced everyone from that moment forth could well travel in time, and so in the millions of years after time travel has been invented there may well be billions (or more!) of time travellers.

The Slicing Thesis: If (i) x and y exist in universe α; (ii) x time travels to target time t and (iii) y time travels to a different target time t', then x ends up in a universe β (which shares all the temporal parts of α up until time t) and y ends up in universe γ (which shares all the temporal parts of α up until time t'), where α, β and γ are all distinct universes.

The choice of the name of this thesis will soon become obvious, but first we need a brief exposition of the extant scientific literature on time travel.

Current scientific opinion maintains that to travel back into the past you must travel through a special region of spacetime, one that connects a region in the future with a region in the past (as Deutsch puts it, a time machine would 'not be an exotic sort of vehicle but an exotic sort of *place*' [Deutsch 1997: 296; his emphasis]). Various factors may make a region suitable for time travel. For example, the region may be warped by cosmic strings [Gott 2001: 99-110], by a Tipler Cylinder [Tipler 1974], by a rotating Kerr black hole [Gribbin 1992: 175-6], by a specially constructed wormhole [Morris *et al* 1988], or maybe it isn't warped at all and the region is just a particular path through a peculiar spacetime [Godel 1949]. Regardless of what makes such regions special, generically label them 'gateways'.

The second thing current scientific opinion maintains is that when you traverse the gateway you will travel back in time by a set period. For instance, a gateway may send you back in time by exactly ten minutes. So if an object passes through the gateway at 10:50, it will arrive back in the past at 10:40, whilst if it travelled through at 10:51 it'd arrive back in the past at 10:41.

With these two observations in place, we can justify the name of the Slicing Thesis. When we pass an extended material object through the gateway there is *some* period of time between the first part going through the gateway and the second part doing likewise. The interval will be tiny compared to the millennia that separate the target times of Hank and Marty, but given the Slicing Thesis the interval is irrelevant. So imagine that an object, y, (from universe α) travels through a gateway: y leaves the present over an extended interval, that has as parts the instants t_1, t_2, t_3...; y arrives in the past over a corresponding interval, that has as parts the instants t'_1, t'_2, t'_3...; y has a decomposition into two-dimensional slices, x_1, x_2, x_3... where each slice corresponds to the two-dimensional part of y that goes through the gateway at the corresponding instant. So x_1 is the two-dimensional slice of y that first crosses the gateway at t_1, x_2 is the two-dimensional slice of y that crosses at t_2 and so on and so forth. So each of x_1, x_2, x_3... depart the present at instant t_1, t_2, t_3…, and consequently each part arrives in the past at instant t'_1, t'_2, t'_3... The target times of each of the xs is therefore distinct, and so given the Slicing Thesis, each of the xs arrive in a different universe. For instance, x_1 will arrive in a universe identical to α up until t'_1, whilst x_2 will arrive in a universe identical to α up until t'_2. But as α doesn't include the arrival of x_1 at t'_1 (in the same way that the original universe I am born in won't include Marty arriving back in 1955, or Hank arriving in 1000 BC) the universe x_2 arrives at won't include x_1 either. Thus x_2 arrives in a universe without x_1 at t'_1. The same applies to all of the rest of the xs – they each arrive in a universe where the others xs aren't at previous times. So in passing through the gateway, y has been sliced into numerous two-dimensional portions which are then spread across the multiverse.

And so we have it. If we live in a world where time travel is achieved only by the use of such gateways (as is the verdict of those within the scientific community who are inclined to accept the possibility of time travel) then given the Multiverse Thesis extended objects cannot time travel. Any attempt to do so turns such objects into an infinite number of wafer thin two dimensional slices spread across an infinite number of distinct universes. Gateways are not time machines (at least not for extended objects) but are instead the ultimate slicing machines.

Before finishing, let us consider if there is an alternative: a thesis that is neither the Interval Hypothesis or the Slicing Thesis. If we're using Deutsch's version of the Multiverse Thesis then we might believe that the correct interpretation of quantum mechanics will somehow guarantee that if time travelling objects are interacting in a particular way (that the parts of the object are, say, appropriately entangled) then they all travel to the same universe.[7] Perhaps an object's parts are appropriately entangled if they're touching, or if they're all mereological parts of the same composite, or the condition they must meet is some complex condition couched in quantum mechanical terms. Pick whichever example you care for as, whatever you choose, we can generate situations similar to that of the eighteen billion time travellers that plagued the Interval Hypothesis. For instance, imagine that if two travellers hold hands whilst going through a portal back in time then they end up in the same universe (*a fortiori* the Slicing Thesis is false). But this is still the Interval Hypothesis, except now the interval varies upon conditions surrounding the time travelling objects, and that variation doesn't prevent the 'eighteen billion time traveller' situation at all. If, in your garden, you have a time machine where a chain of people slowly walk through, hand in hand, and have been for a very long time (and Hank went first) then when hold hands with someone at the end of the chain and travel through, I'll end up in Super Hindu world. So we're back to the gateway not being a time machine but a universe hopper. Similarly for similar objections using a different condition. Whilst we might bring forth an explanation (be it from quantum mechanics or whatever) for the object remaining unsliced, this does not change the fact that there is an interval whereby objects travelling to target times not separated by more than that interval end up in the same universe. The interval might be a result of considerations in quantum mechanics (etc.), it might vary depending upon other conditions, but the cause of the interval is irrelevant (and the conditions under which it varies are irrelevant) as to whether we can construct scenarios like the eighteen billion time travellers which lead us back to the scenario where Marty travels to 1955 to find himself surrounded by Super Hindus. Thus, I believe that it is a hard choice between the Interval Hypothesis (*a fortiori* the Multiverse Thesis amounting only to mere universe hopping) and the Slicing Thesis (*a fortiori* no extended objects time travelling).

Finally, one referee has suggested that this is *exactly* what we should expect from wormholes – that if I make a gateway to the past and then go through it at a later date, I should *expect* to be in some weird universe like the Super Hindu world. So this line of argument goes, the Hank and Marty problem only seems weird because we might, at first, think of them as teleporting through time or what have you; once you stipulate that they travel in time via wormholes, the Super Hindu case seems more sensible. This may be the case, but it's by the by for this is just to say that we *expect* a wormhole to be a mere universe hopper rather than a time machine. If this were right, then all it would do is show that one never expected the Multiverse Thesis to allow for time travel in the first place.

6. Conclusion

I conclude, then, that the Multiverse Thesis should be paired with the Slicing Thesis, and we get the consequence that any extended object that passes through a gateway will be destroyed by being sliced into pieces. I also presume it is an unwelcome consequence.

It may be so unwelcome as to persuade certain adherents of the Multiverse Thesis to give up on it. One motivation that is scuppered is accepting the Multiverse Thesis on the purely philosophical grounds that it provides the best explanation of putative time travel scenarios. As most such scenarios involve extended objects travelling in time, the Multiverse Thesis will turn out to be unsuited for such explanations. (You could save scenarios where extended objects travelled through time by means other than by gateways, but I take it that as scenarios using gateways are the most plausible according to contemporary physics, then they are ones we should have a particular interest in saving). Other motivations may be likewise ruined.

But for others it may not dissuade them at all, and the consequence will remain an interesting *result* of the Multiverse Thesis. For instance, if Deutsch is correct, and his work demonstrates that the Multiverse Thesis is the correct model of time travel (I'm no physicist, so who am I to say he's wrong!) then whilst the Slicing Thesis is unwelcome, it is nonetheless

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[7] With thanks to a referee for raising this issue.

true (this is the position of Everett [2004]). The unwelcome consequence still has some interesting corollaries.

First, it leaves open an empirical test as to whether or not the Multiverse Thesis is true. If, upon time travelling through a gateway, an extended object is *not* sliced into two dimensional sheets, we can be certain that the Multiverse Thesis is false (and a different model of time travel is called for).

Second, it has some minor metaphysical consequences. We must commit ourselves to the possible existence of zero-, one- and two-dimensional objects,[8] a commitment that not everyone is happy with [Cartwright 1975; Uzquiano 2006]. We must also commit ourselves to the impossibility of extended objects that are impossible to divide (which means that extended mereological simples are necessarily divisible) for any object can be divided by passing it through a gateway.

Third, it has at least one major metaphysical consequence: that some gunky spacetimes are incompatible with gateways. A gunky spacetime is one such that every region has a sub-region. Some gunky spacetimes will be such that every region is extended in all dimensions.[9] If an object passed through a gateway in such a world then whatever slice arrives in the past must, necessarily, be extended in all dimensions, and must have passed through over an extended interval of time. But given the Slicing Thesis that slice should be such that the front half arrived in one universe, and its back half in another, not that they arrived together in one and the same universe (which they did, because the slice has to be extended, and so clearly has a front and a back half). So we have a contradiction if any object tries to travel back in time in such a gunky spacetime. So either time travel is impossible in such universes, the Multiverse Thesis is false at those universes or such spacetimes are impossible. The first option is implausible, as there's no reason to believe that the possibility of time travel and the gunkiness of spacetime are related, and that the laws of physics must necessarily preclude time travel solely because a spacetime is gunky. The second option is equally strange. If the Multiverse Thesis were contingent then in gunky spacetimes some *other* model of time travel must be true, with its own response to the Grandfather Paradox. But if there's an acceptable response to the Grandfather Paradox that doesn't involve the Multiverse Thesis one has to wonder why that it isn't true necessarily (at all worlds and all universes), thus making the Multiverse Thesis redundant. So the final response is that such gunky spacetimes are impossible. But that has to be counted as a cost: such spacetimes don't seem at all impossible at first glance.

Fourth, it is an interesting fact that my argument here dovetails neatly with Everett's conclusions [2004]. As previously noted, Everett has an argument – couched in the language of quantum physics – for much the same conclusion, which was specifically against Deutsch's theory. But now we have another proof which involves no quantum physics or knowledge of many-world interpretations of quantum mechanics, and which demonstrates that the

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[8] It is clear where I get the possibility of two-dimensional objects from. Since we can rotate these objects and pass them through a gateway again, we could have one-dimensional objects, and since we can rotate those one-dimensional objects and pass them through a gateway we could have zero-dimensional objects.

[9] I believe that such gunky spacetimes are the *natural* way of thinking about gunky spacetimes. But they are not the only way *pace* McDaniel [2006: 41-2] who argues that *all* gunky spacetimes must be such that their sub-regions are extended in all dimensions. There are two ways that an *n*-dimensional gunky spacetime could have some regions with less than *n* dimensions. One way is to have a spacetime constructed out of nondenumerably many points – like a standard spacetime – but where those points each have further points as parts. The spacetime would thus be gunky (it might seem unrealistic for points to have further points as parts but at least one philosopher [Forrest 2004: 354] believes it is possible). A second way is that there could be an *n*-dimensional spacetime which has a decomposition into an infinite number of *n*-1 dimensional regions, the sub-regions of which are gunky (and always extended in *n*-1dimensions). Such a spacetime would be gunky, as every region has a sub-region, but there would nevertheless be some regions that failed to be *n* dimensional.

Multiverse Thesis *in general* (not just the specific version Deutsch provides) runs into such problems. Moreover, that it's an argument from armchair philosophy and not physics is notable, for it is not often that the same conclusion can be reached by both science and metaphysics.

Fifth, it stands as a stark warning: should you find the Multiverse Thesis plausible, then you should think twice before taking up an offer of travelling through time.

Given these corollaries, even if you are not dissuaded from giving up on the Multiverse Thesis, you should find this paper interesting nonetheless.[10]

7. Bibliography

Abbruzzese, J. 2001. On Using the Multiverse to Avoid the Paradoxes of Time Travel, *Analysis* 61: 36-8.

Cartwright, R. 1975. Scattered Objects, in *Analysis and Metaphysics* ed. K. Lehrer: 153-71.

Davies, P. 1995. *About Time*, London: Penguin Books.

Deutsch, D. 1991. Quantum mechanics near closed timelike lines, *Physical Review D* 44: 3197-3217.

Deutsch, D. and Lockwood, M. 1994*a* (March). The Quantum Physics of Time Travel, *Scientific American* 270: 68-74.

Deutsch, D. and Lockwood, M. 1994*b* (September). Deutsch and Lockwood Reply, *Scientific American* 271: 5.

Deutsch, D. 1997. *The Fabric of Reality*, London: Penguin Books.

Everett, A. 2004. Time travel paradoxes, path integrals, and the many worlds interpretation of quantum mechanics, *Physical Review D* 69: 124023.1 – 124023.14.

Forrest, P. 2004. Grit, Gunk and the Banach-Tarski Paradox, *The Monist* 87: 351-70.

Gödel, K. 1949. An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation, *Reviews of Modern Physics*, 21: 447–50.

Gott, J. 2001. *Time Travel in Einstein's Universe: The Physical Possibilities of Travel Through Time*, London: Orion Books.

Greene, B. 2004. *The Fabric of the Cosmos*, London: Penguin Books.

Gribbin, J. 1992. *In Search of the Edge of Time*, London: Penguin Books.

Hewett, L. 1994. Letters to the Editor, *Scientific American* 271: 5.

Lewis, D. and Lewis, S. 1970. Holes, *Australasian Journal of Philosophy* 48: 206-12.

Lewis, D. 1976. The paradoxes of time travel, *American Philosophical Quarterly* 13: 145-52.

McDaniel, K. 2006. Gunky Objects in a Simple World, *Philo* 9: 39-46.

Morris, M., Thorne, K. and Yurtsever, U. 1988. Wormholes, Time Machines and the Weak Energy Condition, *Physical Review Letters* 61: 1446-9.

Richmond, A. 2003. Recent Work: Time Travel, *Philosophical Books* 44: 297-309.

Tipler, F. 1974. Rotating Cylinders and the possibility of global causality violation, *Physical Review D* 9: 2203-06.

Uzquiano, G. 2006. Receptacles, *Philosophical Perspectives* 20: 427-51.

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B15 2TT