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Hypothetical Analysis about computational feasibility of Time Travel

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***Abstract*— Time Travelling has always been considered a fantasy never fulfilled .There have been many assumptions regarding how to fold the fabric of space time to let light reach from point A to Point B without travelling the entire length, and this all has been seen from the scientific point of view . But no one has put forward an apt representation as to can us or can we not produce Time travel computationally? The feasibility of this problem is aptly and properly analyzed in this paper and we have tried to reach a final consensus if time travel is computationally feasible at all or not?**

***Index Terms*-computationally, consensus, scientifically, time travel.**

I. INTRODUCTION

As humans, we have always been beckoned by faraway times and places. Ever since man realized what the stars were, we have wondered whether we would ever be able to travel to them. Such thoughts have provided fertile ground over the years for science fiction writers seeking interesting plotlines. But the vast distances separating astronomical objects forced authors to invent various imaginary devices that would allow their characters to travel at speeds greater than the speed of light. (The speed of light in empty space, generally denoted as c by physicists, is 186,000 miles/second.) To give you an idea of the enormous distances between the stars, let's start with a few facts. The nearest star, Proxima Centauri (in the Alpha Centauri star system) is about 4 light-years away. A light-year is the distance that light travels in a year, about 6 trillion miles. So the nearest star is about 24 trillion miles away. It would take a beam of light traveling 186,000 miles per second, or a radio message, which would travel at the same speed, 4 years to get there. On an even greater scale, the distance across our Milky Way galaxy is approximately 100,000 light-years. Our nearby neighbor galaxy, Andromeda, is about 2,000,000 light-years away. With present technology, it would take some tens of thousands of years just to send a probe, traveling at a speed far less than c, to the nearest star. It's not surprising then that science fiction writers have long imagined some sort of ―shortcut‖ between the stars involving travel faster than the speed of light. Otherwise it is difficult to see how one could have the kinds of ―federations‖ or ―galactic empires‖ that are so prominent in science fiction. Without shortcuts, the universe is a very big place. And what about time, that most mysterious feature of the universe? Why is thepast diff erent from the future? Why can we remember the past and not the future? Is it possible that the past and future are ―places‖ that can be visited, just like other regions of space? If so, how could we do it?

II. PHYSICAL THEORIES REGARDING TIME TRAVEL

Light Cones

Event A lies inside the future light cone of O, so O and A are separated by a time like interval, for example, s2 < 0. This means that a particle or signal traveling slower than light, emitted at O at t = 0, can affect what is going to happen at A. Event B lies on the future light cone of O, so O and B are separated by a light like (―null‖) interval, that is, s2 = 0. Therefore, a light signal emitted at O can affect what is going to happen at B (in fact, the light ray arrives just as B occurs.) Event C lies inside the past light cone of O. This means that O and C are separated by a time like interval, so a particle or slower-than-light signal emitted at event C can affect what is happening at O. Similarly, event D lies on the past light cone of O, so O and D are separated by a light like interval, and so a light signal emitted at D can affect what is happening at O. The events E and F lie outside both the past and future light cones of O, so each of these events are separated from O by a space like interval, that is, s2 >0. This means that for O to either affect, or be affected by, events E and F would require faster-than-light signaling. (A world line connecting O with events E or F would have a slope of greater than 45°, and thus lie outside the light cone.) Therefore, events E and F can have no causal influence on O and vice versa. The time order of events A through D are invariant, that is, the same in all frames of reference. The time order of events E and F is different in different inertial frames. In some frames E and F will be seen as simultaneous; in other frames E will be seen to occur before F, or vice versa.

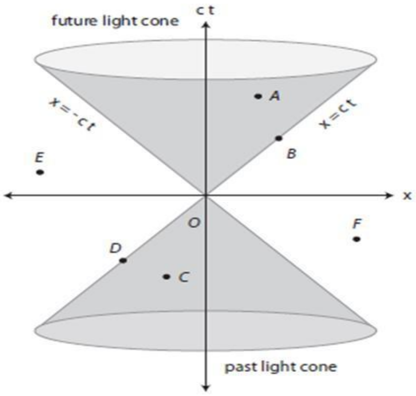

FIG. 1: The light cone. The event O represents The "present moment." The figure shows what Events can affect, and be affected by, event O.

Theory of general relativity

Our current understanding of what time is and what space is comes from Einstein's theory of relativity. But, before I describe relativity, I'd first like to describe the way that people thought of space and time before Einstein — the way that Issac Newton envisioned space and time to be. I could simply begin with Einstein's theory, but I think doing so would rob you of a full appreciation of its crazy brilliance. So we'll talk about Newton briefly first.

According to Newton, space and time were, in a sense, absolute. Space is the —stage‖ on which all the events of the Universe happen, and time is just this thing that passes at a constant rate for all objects in the Universe at all places. According to Newton, space and time exist out there independent of any objects; no object can affect space or time.

To give you a feeling for absolute space and time, suppose that two events happen — lightning strikes somewhere, say, and then somewhere else a baby cries. And let's say you've got a watch and you time to see how long after the lightning strikes it takes for the baby to cry. In Newton's view, everybody in the Universe will get the same number. If you get 5 seconds, then everybody else who measures it will get the same 5 seconds. (That's assuming, of course, that they're smart observers, i.e., that they know how to measure! A stupid observer can, of course, mess up and get a different number.) Furthermore, if you measured the distance between the two things — the lightning and the baby — and you get some number, like 2 miles, then everybody in the Universe who measures that distance will get the same thing. Space and time are absolute. All of which is quite obvious — it shouldn't make any difference whether I'm using my watch when I'm sitting down, or riding a bus, or flying a plane. Why should it? That would be crazy!

Well . . . it turns out that Nature is crazy, because Newton's ideas were wrong. About 100 years ago, people noticed that although Newton's theory works for almost every physical phenomenon that people had observed in the world, there are some things it can't explain or else has a really hard time explaining. I'm not going to try to explain what was wrong with Newton's theory here — that's another story for another day — but for now just know that Newton's theory was in trouble.

Fortunately, there was a smart guy who came along and fixed all the mess. He was a young worker (only 25) at a German patent office, his name was Albert Einstein, and he was a virtual nobody. In 1905, he proposed his special theory of relativity, which very, very elegantly resolved all of these problems. The theory itself is extremely simple. It has only 2 fundamental principles, or —postulates‖:

1. The laws of physics are the same for —everybody.‖
2. The speed of light is the same for —everybody.‖

These are the fundamental postulates of special relativity. (I'll explain in a minute why I put —everybody‖ in quotations.) It doesn't make any sense to ask why they're true. They just are — that's why we call them postulates. (You might remember certain unprovable —postulates‖ or —axioms‖ from geometry, if you've ever taken any geometry.)

The first postulate is very easy to accept. All it says is that Nature is fair to everybody! If I drop a piece of chalk here, and you drop a piece of chalk there, the laws that apply to my chalk are the same as the laws that apply to your chalk. For example, the law of gravity is the same. Gravity will pull on the chalk in the same type of way for you as for me. They're also the same as the laws that apply if I'm walking and I drop the chalk, or if I'm running, or if I'm in a train. The laws are always the same.

The second postulate is the one that's crazy. Let me first explain what I mean by —everybody.‖ By —everybody,‖ I simply mean everybody that's moving at a constant speed (or, more precisely, everybody that's moving at a constant velocity, which is speed plus direction, but for our purposes we'll keep things simple). If I'm standing still, I'm obviously at some constant speed, and if I'm walking at 3 miles per hour I also am. However, if I start out slow and then go fast, my speed changes, so I'm not going at a constant speed. Special theory would not apply to me, then.

I would then be an accelerated observer, and for that you'd need Einstein's general theory of relativity, which I'll discuss a bit later.

But let's get back to the second postulate. Suppose I'm traveling at some constant speed and measure the speed of light somehow. I'll get some number. Then I travel at some other speed and measure the speed of light in this scenario. The second postulate says that I'll get the same number. This is incredibly strange! Ordinarily, we'd expect that that they'd be different. For example, if I'm standing still and throw a ball in front of me, you'd definitely guess that if I were running and threw the ball, then I'd measure a smaller speed for it (supposing I throw the ball with the same force in both cases). But, if that ball were light, I'd get the same, exact speed! This is extremely strange, but this phenomenon — that lights travels at the same speed for everyone — has been confirmed many times by experiment.

Now, when you look at these two postulates, the second one might sound weird, but you might not guess that they would have very profound consequences. Well, it turns out they do! Probably the most interesting has to do with time — an effect known as time dilation — because it allows for the possibility of time travel to the future.

Time Dilation

Suppose it's a very beautiful summer day — like today, as I type these notes — and you decide to do what you like doing best on summer days, namely, to go to the train track and watch the trains go by! So you go to the train track and you sit down on a bench. You've also brought your clock along with you, because you like to measure things with it. Now, it turns out that, according to the two postulates of special relativity (get ready for it), you sitting on the track will observe any clock on the train to tick slower than your clock. This effect — that moving clocks run slow — is known as time dilation. When you sit down and really think about these two postulates, it's simply what you find.

Now, it's important to be precise here. When I say that ―moving‖ clocks run slow, I have some kind of observer in mind; the clock has to be moving relative to that observer. For example, when I walk by you lying down on a couch, I'm traveling at some speed according to you. I'm moving relative to you, so you will in principle observe my clock to tick slower than yours. But, of course, according to me, I'm not moving at all. According to me, you on the couch are the one that's moving, and your clock is the one that's ticking slow! So this effect of time dilation is a symmetric kind of effect. I say that your clocks tick slow, but you say that my clock ticks slow. Neither one of us is wrong — we simply have different perspectives.

Curved Spacetime

According to general relativity, mass curves spacetime. And the more mass there is in a region of space, the more spacetime will be curved there. Now, what is spacetime, and what does it mean for it to be curved? Well, according to general relativity, space and time are intimately connected, and they may together be thought of as forming a unified object called ―spacetime.‖ In a world where this is no gravity, we say that spacetime is not curved; it is flat. This is the world of special relativity. Where spacetime is flat, space and time operate exactly as described in the notes ―Special Relativity Formulas‖: moving clocks run slow, objects in motion are shorter than they are at rest, and so on – each according to certain special-relativistic formulas found in those notes.

Interestingly, it turns out that space and time operate differently in curved spacetime than in flat spacetime. In curved spacetime, those special relativity formulas are no longer true. For example, one of the coolest features about curved spacetime – not present in flat spacetime – is an effect known as gravitational time dilation. According to general relativity, clocks tick slower near massive bodies than far away from them. In other words, the greater the gravity, the slower a clock will tick; therefore, the more curved spacetime is, the slower a clock will tick. Thus, a clock on the surface of the Earth will run slower than a clock 10 miles above the Earth's surface, because the former clock is in a region where spacetime is more curved than in the latter region.

As you may already see, gravitational time dilation presents an alternative method for traveling into the future! Suppose you sit near a very massive object, where spacetime is very curved. Then (depending on how massive the object is), while a very short amount of time may elapse for you, a very long amount of time may elapse for someone far away from the very massive object. As a result, you'll have effectively traveled into the future!

III. TIME TRAVEL TO THE PAST

I mentioned earlier that general relativity allows for the possibility of time travel to the past. I'll now describe one method how (yes, there are others!). This method involves wormholes.

General relativity, in its bizarre yet wonderful nature, allows for the existence of very strange entities known as ―wormholes.‖ A wormhole is simply a path between two places in space. However, it isn't any old path between two places – it's a shortcut between them. For example, the star Sirius is approximately 54 trillion miles away, so that if you traveled at nearly the speed of light, it would ordinarily take you about 9 years to reach it. But if the Earth and Sirius were connected by a wormhole, then it's possible for you to travel through the wormhole – which may only be 10 feet long – and thereby reach the Andromeda Galaxy in a matter of seconds!

Now here's how a hypothetical time machine, capable of traveling into the past, could be made out of a wormhole connecting Earth and Sirius. First, (somehow) take the end, or ―mouth,‖ of the wormhole near Earth, accelerate it up to a very high speed – near the speed of light – and then bring it back to Earth. As a result of the type of time dilation discussed in ―Time Travel to the Future via Special Relativity,‖ we then expect that the accelerated mouth of the wormhole will have aged less than the mouth of the wormhole that remained stationary near Sirius. However, it is a very peculiar prediction of general relativity that this observation is only true for observers outside the wormhole! If you were inside the wormhole, then general relativity predicts that, according to you, both mouths of the wormhole will age just as much – they will always be synchronized, regardless of their motion.

So, let's suppose that you entered the mouth of the wormhole which was just accelerated, and it resulted in that mouth aging 5 years while the other mouth aged 10 years. And say that, at the end of the process, it's the year 3005 at the accelerated mouth and the year 3010 at the mouth that remained stationary. Then, you go inside the wormhole, and you observe that it's 3005 at the stationary end. Once you exit through the stationary end, it will still be 3005 there. Thus, you've traveled into the past of the stationary mouth of the wormhole!

Just to give you some real-world perspective, the two mouths could theoretically be located in your living room, before you accelerate one of the mouths. So, initially, it might be the year 3000. You accelerate one of the mouths up to a very high speed, and then bring it back to your living room, where your calendar shows it to be the year 3010. So, the accelerated mouth of the wormhole aged 5 years whereas the stationary mouth aged 10. Well, according to general relativity, if you walk through that accelerated mouth into the other mouth located in the living room, you'll soon find it to be the year 3005 again! How lovely!

Unfortunately, wormholes are highly unstable objects, meaning that very shortly after they're constructed they fall apart. However, this instability can be overcome if you've got some exotic material – matter which essentially has negative mass(!). Also, the actual construction of a wormhole appears to be rather difficult, since, for example, a time machine might be required for the construction process. But if you can overcome these difficulties, the past is yours!

Finally, it must be said that this type of time machine only allows time travel to as far back in time as when the time machine was created. Alas, it doesn't look like we'll be able to re-witness (through wormhole time machines, anyway) the birth of rock 'n' roll, or our nation's declaration of independence,... or Einstein's discovery of relativity – which led to all this beautiful mess!

IV.TIME TRAVEL TO THE FUTURE

Of course time travel to the future is possible – we're currently doing it, 1 second per second! The question is, can we move arbitrarily far into the future of our surroundings while we ourselves age only slightly? According to special relativity, the answer is a resounding YES. Here's how: simply find a spaceship, take off from Earth, eventually reaching a speed very close to the speed of light, and then turn around, eventually returning to Earth. Suppose your spaceship travels at 99.9992% the speed of light, for example, and you travel away from Earth for 5 years (at a reasonably constant speed), and then spend 5 years returning to Earth (again, at a reasonably constant speed). Then, while 10 years have passed by for you, 1,000 years will have passed by for Earth!

This result is, of course, due to time dilation – the effect of special relativity that moving clocks run slow. According to an observer on Earth, the clocks on your spaceship will be moving slower than the observer's clock. Therefore, the amount of time that elapses for you, while you are on the spaceship, will always be less than the amount of time elapsed by a clock on Earth. (But wait! Can't you, the spaceship observer, just as well say that the Earth clocks are running slow, and therefore while 1,000 years passes by for you, only 10 years will pass by for the them? No, you can't!!! You aren't truly an inertial observer, because you have to decelerate once you decide to turn around and return to Earth. Remember that inertial observers are those moving at constant velocity.)

That's all there is to it! Of course, how you can actually get a manned spacecraft up to a speed of 99.9992% the speed of light is another question... The highest speed approached so far by a manned spacecraft is only 0.0037% the speed of light. However, the highest speed we've ever sped tiny particles up to is over 99.9999% the speed of light. So, in principle, it is possible to accelerate anything very fast. All that we currently lack is the technology and the resources.

V. CONCLUSION

In conclusion, let us return to the question. what does the existence of solutions to Einstein's field equations with exotic causal structure imply regarding the nature of space and time according to GR; or, more generally, whether physics permits such exotic causal structures, and if so, what does this permission mean for the nature of space and time? Our first focus has been on the implications of time travel, de_ned in terms of the existence of CTCs. Many philosophers have attempted to dismiss this question as illegitimate, on the grounds that a variety of paradoxes establish the logical impossibility, metaphysical impossibility, or improbability of time travel in this sense. We found these arguments wanting, although they do usefully illustrate the importance of consistency constraints in spacetimes with CTCs. It may come as a shock to discover that the consistent time-travel scenarios are not just the stu_ of _ction: there are several chronology-violating spacetimes that exhibit the local-to-global property described in x3 for appropriate choices of _elds. However shocking the existence of these solutions may be, we assert that there is no footing to reject them due to alleged paradoxes, and no basis for imposing a causality condition insuring \tame" causal structure as an a priori constraint. Setting aside objections based on the paradoxes, attempting to answer our question leads into a tangle of interconnected issues in philosophy of science and the foundations of GR. We hope to have at least clearly identi_ed some of these issues and illustrated how their resolution contributes to an answer. First, consider cosmological models such as G• odel's that are not viable models for the structure of the observed universe. Assessing the importance of these models turns on di_cult questions of modality applied to cosmology. Even if we grant that GR provides the best guide to what is physically possible in cosmology, the existence of models like G• odel's does not directly BMPV black hole in order to produce gravity. These results are very preliminary and much remains to be seen, not the least of which is whether any of the mentioned theories can o_er a full quantum naked CTCs leads to the formation of a shell of gravitons with the D-branes enclosed inside the black hole. This mechanism, which is akin to the \enhancon mechanism" that string theorists use to block a class of naked singularities, precludes the system from speeding up beyond the critical value. undermine the use of special structures such as the preferred foliation in the FLRW models without a questionable modal argument or claim that such models reveal something signi_cant about the laws of GR. Thus, if we were only considering cosmological models with exotic causal structure, it would be di_cult to answer Maudlin's challenge. Maudlin claims that metaphysicians can safely dismiss exotic spacetimes because dynamical evolution according to Einstein's _eld equations does not force CTCs to arise from possible initial data. But this assertion presumes a resolution of a second open issue, the cosmic censorship conjecture or (some form of) the weaker chronology protection conjecture. Given a proof of the cosmic censorship conjecture, one could clearly demarcate situations in which Einstein's _eld equations coupled to source equations satisfying constraints such as the energy conditions generically lead to globally hyperbolic spacetimes from situations in which dynamical evolution leads to Cauchy horizons, and the possibility of extensions beyond them containing CTCs. There are still signi_cant obstacles to a proof of cosmic censorship due to our lack of understanding of the space of solutions to GR. Similarly, a proof of a su_ciently powerful chronology protection conjecture imposing some principled conditions on a spacetime's properties would underwrite Maudlin's claims. Alas, this second issue remain open to date, not least because it is far from obvious how the blanks in Conjecture 1 concerning suitable initial data and physically reasonable spacetimes ought to be _lled in. A third issue concerns the impact of incorporating quantum e_ects. Does the space of solutions of semi-classical quantum gravity, or even full quantum gravity, include time- machine solutions or solutions with CTCs? Thus, our investigation went beyond a mere analysis of the foundations of GR, in at least two respects. First, we have turned to semi-classical quantum gravity and listed\ how the quantum can be more permissive in tolerating the violation of energy conditions and thus be more lax about the suitability of the matter sector. Although no one really takes semi-classical theories seriously as competitors for _nal theories of quantum gravity, important lessons of how spacetime and quantum matter interact may be gleaned from them. Second, in a brief survey of three approaches to full quantum gravity, causal set theory, loop quantum gravity, and string theory, we have found that string theory in particular seems to nourish the hopes of aspiring time travellers, while one shouldn't be too hasty in ruling time travel out in the case of loop quantum

theory of gravity. But we hope that the reader walks away from this article with a _rm sense that these foundational analyses in GR, semi-classical, and full quantum gravity constitute important attempts at both understanding the classical theory, as well as illuminating the path towards a quantum theory of gravity.

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