



## A Generic View of Time Travel

---

Deep Bhattacharjee, Soumendra Nath Thakur and  
Priyanka Samal

EasyChair preprints are intended for rapid dissemination of research results and are integrated with the rest of EasyChair.

June 30, 2023

# A generic view of time travel

Deep Bhattacharjee<sup>123</sup>  
Soumendra Nath Thakur<sup>4</sup>  
Priyanka Samal<sup>5</sup>

<sup>1</sup>Electro-Gravitational Space Propulsion Laboratory, India

<sup>2</sup>Integrated Nanosciences Research, India

<sup>3</sup>CXAI Technologies Ltd., Cyprus

<sup>4</sup>Tagores Electronic Lab, India

<sup>5</sup>Independent Researcher in Theoretical Physics, India

<sup>123</sup>*Corresponding author email: itsdeep@live.com*

**Abstract:** Time itself being the temporal dimensions can be manipulated by means of clever physics to make a time travelling domain in the backyard of your own garden. The principles of this are introduced along with physics, to capture the beauty of time travelling on a grander scale by some arbitrarily modified civilizations in the far-away futures. This starts with the basic notions on the perspectives of time with regards to its implications in the physics of time travel.

**Comments:** Questioning the conundrums of time travelling and making it possible by emphasizing fictions with mathematics.

**Keywords:** ANEC – CTC – Entropy.

July 2023

---

*The authors hold no conflicting interests.*

*This paper is a updated and modified version of the preprint*

*<https://doi.org/10.22541/au.162989742.27649499/v1>*

## *Philosophical aspects of Time*

Time is also known as the Temporal dimensions which is orthogonal to any number of spatial dimensions (those spatial dimensions being mutually orthogonal to one another). If we call the spatial dimensions as  $d_s$  and the temporal dimensions as  $d_t$  then the inner product between these two dimensions yields zero. This can also be stated as time is independent from the spatial dimensions but still time is not absolute. It changes its duration; it slows down sometimes or fastens sometimes depending on the velocities which indirectly causes a change in the form of a contraction of spatial dimensions called as Fitz-Gerald Lorentz Contraction. Time is a one-way arrow, but it dilates, it dilates depending on a strongly coupled Gravitational field and this results in a spectacular Phenomenon called the time dilation. The relativistic norm of the time can be seen in both from an inside going person to an outside observer travelling inside the black hole. Of course, all of this is mathematical as because nobody can fall nor get inside the black hole as this first causes spaghettification and then death by tearing the Atoms of the body Apart. Causality plays an important role by taking time as a function. This again generates the strong and weak cosmic censorship hypothesis. Causality plays with the array of Time which simply denotes that for every cause, there is an effect. Moreover, no singularities can be seen from future null infinity as because they are guarded by an event horizon. This elaborates the reason that what we do today will affect tomorrow. And what effect tomorrow has is solely dependent on today. Therefore, this hypothesis can't be changed as our action determines our consequences and on the other hand the consequences can be treated as the effect of our actions. Moreover, this leads to the idea of determinism. If we have all the initial data at the present time regarding the present time, then we can easily compute what will happen tomorrow. We can easily predict by analyzing our initial data and this in somehow predicts the future before the future even kicks in. This in turn states that even if the causality can be violated then also at the present time we can predict what is going to happen tomorrow (although if tomorrow is forbidden in our universe). But can Causality be violated? Can this be happen that there exists a universe in which the Past action or the past time-like curves wont never actually reach future or the Future is prohibited from the Cause-Effect Relationship.

This delves into a deep philosophical intuition that needs to be addressed. Moreover, what if the cosmic censorship hypothesis proved wrong by means of an accelerating and expanding universe as the recent study shows. The relativistic nature of time is inherently dependent on the speed of light although it is a theory of a question whether the causality can be violated at the speed of light? Will the Photons Experience a Cause-Effect relationship, according to special relativity the answer is no as because to a Photon the Time is eternal therefore, it is nothing but experiencing only a Random moment of Present or different fragments of Present without any relation to the Past and Future. Another effect of time is directly related to the second law of Thermodynamics which states that the entropy will increase with Time. That means the past is Proportional to Less Entropy and the Future is Proportional to a more Entropy which in other hand is the Past compared to a more elaborated Future. Entropy means disorder and chaos and this disorder tends to increase as time passes by. This can never be violated as because if this can be violated then Time must move backwards but that is restricted to the laws of Physics until and unless the chronology protection conjecture by Stephen Hawking kicks in and implies that moving to the past is restricted on all forms of matter except the Subatomic scales which implies that Quantum Gravity has something to do with the conjecture. But still now, we don't have a proper understanding of Quantum Gravity and we don't know that whether the effects of quantum Gravity becomes prominent enough to determine the course of time. But it's a conjecture after all and this needs to be generically proven by mathematics. Inter-Dimensional travel is Possible on the scale of strings as because the Graviton being a closed string has no boundary to D-Branes and are therefore not permitted to stay in one single dimension. Gravitons can propagate to multiple dimensions but remember that Time is Orthogonal to the set of Spatial dimensions and Gravitons can only Propagate through Spatial dimensions whether the time dimension remains unaffected by its Propagation. But yes, as we have said that, Time effects Gravity and that effects become Prominent when gravity Encounters the Singularity of the Black hole where the Space-Time is so warped up that even the geometry of space-time forbids the light to escape from it by making the escape velocity closer to that of the speed of Light or even more as light circles in a Prograde as well as Retrograde fashion. Will the Retrograde fashion of Time-like curves still be achievable in our Non-Black Hole Region of the Universe? Retrograde Time-like curve is quite impossible to the laws of Physics as because this raises a Question of the famous Grandfather Paradox.

*“Suppose you went back in the Past to kill your grandfather before he gives birth to your mother and so, what will happen when you will come back to the Future.... Will you still have your mother, of course not as you have already killed your Grandfather in the distant past before your mother has even born, but in the future you still have your mother! This seems contradictory and remains a Paradox. If you look at this thing from another angle, then you may find that Your mother in future has come from a different timeline or it can be said that as soon as you killed your GRANDFATHER , your mother will emerge from an altogether different timeline and therefore she in future is no longer related to the timeline of his father; she evolves in future from a different timeline as compared to her father.... all this sort of things may eventually lead to a Philosophical Paradox and this can't be ignored because of its importance”*

Our timeline eventually gets diverted away into multiple universe and each universe holds a promise of our different possibilities of future but there must be some point when a Clone appears as the identical twin of us in some other universe with a same timeline like us as because infinity tends to converge and repeats itself at certain times.

*“Suppose that you want to be a doctor in this universe but you ended up being an engineer. But there must be some universe where you will ultimately end up becoming a doctor. This doesn't raise an issue as the timeline is different for both of the universe, but if you eventually become an engineer in the other universe, then it can be assumed that the timeline of this you is exactly the same as the timeline of the you in this present universe and this copying occurs due to the infinite number of universes where infinities ultimately converges or tends to converges altogether”*

From the solutions of the Einstein-Field-Equations of the General relativity many solutions of time travel have been approached by different scientists but their theories are inconsistent with the present condition of our universe. Some requires infinitely long cylinder rotated at such a high speed that the centrifugal force will align the Light Cones into a Closed Time-like Curve (CTC) which may permit one to travel back and forth in time at a non-relativistic speed due to the circular adjournment of the time-like curves. But this in effect is actually impractical to us as *“Where from we get an infinitely long Circular cylinder?”* Another approach is the Gödel's solution to the General relativity that permits the Time Travel but only if the Universe has a spin. But our universe is non-rotating hence no such spin at all. From all this impractical solutions, it becomes clear to us that Time-Travel is quite unrealistic and hence are not implemented by either the Physical laws or our universe. But what if some arbitrary advanced civilization proved it Wrong? Although the solutions of various models of General relativity seems impractical to us, it remains a mystery as though if the actual CTC's are existent in this universe or not. Because without CTC, there is no means of any time travel and this idea of time travel can easily be abandoned. Herman Minkowski took over the Einsteinian ideas and contribute a new generator in Special relativity by merging space with Time called as Space-Time. The light cone model has been developed and the metric signature for this lightlike (At the Speed of the Light), spacelike (more than the speed of the Light), timelike (Less than the speed of the light) has been developed with a metric signature of  $(+ - - -)$  or  $(+ + + -)$  depending on the Speed of the Light. The Light cone has two Parts, Past Null Infinity & Future Null Infinity with the Present lying down at the adjournment between the two vertices of the Light Cone. It is as if shining a Torch light and the light eventually takes up a Conic structure with the torch being the Origin of the Light forming the Future Light cone and this can be stretched to the Past in an inverse way therefore making it a subtle Past Light Cone. Past light cone doesn't mean that time is flowing negative; it just means that what if our present can be inversed or the Past can be mapped as the inverse of the Present. An even occurring in the bounded region of the Light Cone are we ourselves doing the day to day work. We may accelerate and change our frame from inertial to non-inertial frame of reference or we may live entirely on the inertial non-accelerating frame of reference. These light cones can be used to construct the closed timelike curves which may provide an indication of the time travel but still we physicists have to

ponder about its implications in the realistic scenario. There is a hypothetical division in our universe and this division marked the regions where there is the possibility of the CTC and where not! The regions have been depicted as chronal regions with no CTC and non-chronal regions with CTC's everywhere. The Boundary between these two regions is known as the chronology horizon. Non-Chronal regions Provide CTC's and as predicted that those CTC's must have to be passed over a horizon and that horizon can be an event horizon which may prevent the observer from detecting casual violation. Our universe is 13.8 billion years old and we can see everything in the Past if we fall inside a Black hole which is actually 13.8 billion Years old as all the Energy of the Universe are Hurling towards the Black hole at a given instant of Time and there should be a Cauchy horizon Present inside the Event Horizon where if any object falls down will simply get vanished as because Physics won't allow for the causality to be violated. Black Holes are the regions into the Faraway Future with a Cauchy horizon which is non-Chronal where as White holes are regions into the infinite past where the light rays are so far away that it doesn't reaches to us. They are infinitely far away in the past and hence they are difficult to observe by us who are moving towards the Present at a hurtling Speed of 4.4 million Kilometers' per Hour if we take into considerations the speed of our earths revolution, cosmic revolution, speed of the universe and so forth. The speed becoming relativistic shows us a Promise that if we can go far beyond the speed of light then we can perhaps see the Hologram of our image in front of our eye. But going beyond the speed of the light is prohibited by the relativity.

Suppose BOB Falls inside a Cauchy horizon and as it is not deterministic thereafter, he will not survive. But in any case if he survives then this will break the Censorship Hypothesis and he may be in a non-deterministic universe different from ours. One of the affine parameters of the time travel is the wormhole or the Einstein-Rosen Bridge and this bridge satisfies an ANEC and the Quantum Stress-Energy-Momentum Tensor,

$$\oint T_{\mu\nu} dx^\mu dx^\nu d\zeta < 0$$

Moreover, negative energy is needed in order to open the mouth of the wormhole and prevent it from collapsing. If the wormhole shallows any particles of dust then the dust will move from time  $T_2$  to time  $T_1$  and again returning to  $T_2$  as because it is going from Past to future and then again to past or else the Region is not Compacted, as because the future Cauchy Horizon needs every particle governed by null geodesics that have no past endpoints and anything moving forward will leave its region. The particle will pile up and rotating infinitely and forming a huge pile of energy distribution which will be prevalent for an infinitesimal time until it dampens down again making the wormhole inaccessible. Although EFE Provides a way of Travelling Between faraway spaces by making Temporal and Spatial Shortcuts which means that The Geometry of the Mouth A at Time  $T_1$  is the same as the Geometry of the Mouth B at the Time  $T_2$ , the time  $T_1$  being equal to time  $T_2$ . Therefore, everything happens at an instant as if there lays a portal between two distant centers which provides the shortcut. But this particle or the wave cannot be a simple electromagnetic wave as because defocusing of energy occurs according to the law of Optics and if the mouth of the wormhole is large

enough then this energy pile up may be reduced to some extent. Apart from wormhole if anyone travels faster than the speed of the light then what exactly will happen to him? The thing that can be theoretically established is that causality will be Broken, and the Person will affect not only eternity, but he will see the Past at the same magnitude as he had crossed or moved apart from the Speed of the light. It is obvious that he can't change his position relative to the space and time but what he does is that he will experience a retrograde notion of the Space-Time that may allow him to see those reflections of light that carried away by the light rays in his past. This can be possible in theory but can't be implemented in practice. This is quite analogue to the frame-dragging phenomenon of the Black hole which states that the Space-Time in the ergosphere is so warped up that the future will be dragged upon to the Present along with the Past.

[ *Travelling in the general sense not only means travelling in time; It also means travelling in Space too; As space-time is a Single entity.*

Therefore, it is perfectly related to travel through space at a Time far greater or equal to the Speed of the Light in order to get close to the Future. Retrograde domain can be possible if Time Travel can be done backwards but this is totally prohibited by the laws of Physics. And regarding future travelling, Well, in every second we are travelling to the future and this is only restricted with a certain speed that is the speed at which the clock ticks. But what should be done if we are trying to go far ahead in time in future? we need a process similar to frame-dragging which will drag the future time to the space. But as this is not only a Time Dragging but also a Frame Dragging therefore, the dragging will twist the geometry of the Space-Time to such extent that the Gravity will be Infinitely large like that of a region near the Singularity. So, in other words this also seems impossible. But what if the past, present, future is coexistent which means....

[ *“You are going to school at the past, You are getting Married at the Present, You will Die at an old age are all ticking at the same time just in different zones...”*

Can this be Possible? If so there exists an infinite copy of every individual if we slice each moment of Space & Time and observe carefully what is happening to us. Time can be called as a closed loop and there exists a every single closed loop for each person's timeline. But why they are not intersecting, well, if we think of the loop as a Perfect circle (which of course means that its not turned and twisted) then this is what exactly resembles our timeline. This simply means that there must be a Point in which the Loop gets closed or else *How can we call it a loop?* But... that joint or junction can be treated as a point infinitely far away in order to prevent us to see our own past; or else our extreme Future will get connected to our Extreme Past even when we are at the womb of our mother at the starting point of our timeline. Time is Strange and it is this Strangeness that Prevent us to know the deeper mystery associated with the idea of time travel.

## *Finding a way of time travel*

Idea of Time Travel in a 5D Universe.  $B$  and  $A$  are events separated by Fountains  $F$  which is the generator of  $H+$  and  $H-$  separated by chronal and non-chronal region. Although we know that Physicists are far away from creating this sort of time machine, but we can say that they certainly would one day as far as the progress of physics has been considered till now.

Imagine yourself standing in a big garden. And that garden is not a normal space but a hyperspace with 4 spatial dimension and 1 temporal dimension. Now there are 2 walls in between which you are standing. Wall A and Wall B. If you go through wall B, you will emerge from Wall A. Let there are 10 walls in linear way. And you continue this entering and exiting. Now, rotate your frame of reference with respect to the walls at a very high speed. The result will give you a tilted spacelike CTC. Now, a fountain generates between wall A and Wall B. Wall B is initially in chronal regions devoid of any CTC. But as this whole engagement is transferred to hyperspace, there likes a generator of CTC and that's between chronal B and non-chronal B. So, you go through B and emerge out in A. You go back through A and emerge out in B'. You go to B' and emerge out to A'. Let the process repeat infinitely in a closed loop of time. Then you will generate several self intersecting CTCs or Closed Timelike Curve. That's in the future Chronology horizon means each and every worldline will go to future but is compactly generated through past or they move asymptotically through the Non Chronal and chronal boundary. This made your speed more than that of light and you will encounter either your past or future whose worldliness are simultaneously connected. You are in a compactly generated Cauchy Horizon. As the events  $E1 E2 E3 E4 \dots$  will encounter through hyperspace, they will churn the space-time along with it which makes the time warp. You have a Past Chronology horizon where all events followed in the past but compactly generated at present. After an infinite hookup with hyperspace you can travel either forward or backward in time. Now, with each self intersecting geodesic, there will be a large refocusing of vacuum polarization which will make the light Ray's divergent and these helps to prevent the time machine from collapsing.

### **Pros:**

- *Average bull energy condition can't be violated.*
- *Chronology protection agent is not active.*
- *Stress energy momentum tensor can't be negative.*

### **Cons:**

- *This is impossible to do.*



You can't make any changes in the future that will lead you in paradox in past. As Non Chronal Projection is on the Chronal side.

Why "non-zero gravitational vacuum fluctuations" needs to be near about unity to prevent time travel?

Consider the equation,

$$\delta G \sim \frac{\ell^2}{D\Delta T(b/2D)^{2n-1}} \approx 1 \text{ 'time travel not possible'}$$

$G$  is non-zero gravitational vacuum fluctuations or polarization.

$\ell$  is Planks length.

$\Delta T$  is the time for each Spacelike geodesic.

$D$  is the distance of wormhole mouth.

$b$  is the radius of wormhole mouth.

If  $\ell = 10^{-35}$  meters,  $D = 10$  meters,  $b = 1$  meters,  $n = 1$  as each space-like geodesic round itself once.

Then if  $D\Delta T$  is  $\ell^2$ , which is invariant of observer's perspective.

Then,

$$\delta G \sim \frac{\ell^2}{D\Delta T(b/2D)^{2n-1}} = \frac{b}{2D} = \frac{1}{2} \times \frac{1}{10} = \frac{1}{20} = 0.05 < 1$$

Time travel is possible if we need 2 instead of that is twice the interval of spacelike geodesics.

On the other hand, if we take,

$$\delta G \sim \frac{\ell^2}{D\Delta T(b/2D)^{n-1}}$$

Then putting all the above values, one leads to 1.

So, to make a time travel, one needs twice the defocusing or 2 wormhole that is 4 mouths in order to make time travel a reality as because 0.05 is far less than 1.

[ *“Thus, there can exists a weakly coupled chronology protection rather than a strongly coupled chronology protection as mentioned here.”* ]

## References:

Bhattacharjee, D., & Roy, S. S. (2021). In quest of higher dimensions – Superstring Theory and the Calabi – Yau manifolds. *OSF - COS*. Published. <https://doi.org/10.31219/osf.io/tcb3y>

Harikant, A., Singha Roy, S., & Bhattacharjee, D. (2021b). Computing the temporal intervals by making a Throne-Morris wormhole from a Kerr black hole in the context of  $f(R,T)$  gravity. *International Journal of Scientific Research and Management*, 9(07), 72–92. <https://doi.org/10.18535/ijstrm/v9i07.aa01> Bhattacharjee, D. (2021).

Positive Energy Driven CTCs In ADM 3+1 Space – Time of Unprotected Chronology. *MDPI Preprint*. Published. <https://doi.org/10.20944/preprints202104.0277.v1>

Hawking, S. W. (1992b). Chronology protection conjecture. *Physical Review D*, 46(2), 603–611. <https://doi.org/10.1103/physrevd.46.603>

Królak, A. (1983). A proof of the cosmic censorship hypothesis. *General Relativity and Gravitation*, 15(2), 99–104. <https://doi.org/10.1007/bf00762469>

Bhattacharjee, D. (2021b). The Gateway to Parallel Universe & Connected Physics. *MDPI Preprint*. Published. <https://doi.org/10.20944/preprints202104.0350.v1>

Stewart, I. (2010b). Grandfather paradox. *Nature*, 464(7293), 1398. <https://doi.org/10.1038/4641398a>

Lanczos, K. (1997). On a Stationary Cosmology in the Sense of Einstein's Theory of Gravitation. *General Relativity and Gravitation*, 29(3), 363–399. <https://doi.org/10.1023/a:1010277120072>

Hawking, S. W., Ellis, G. F. R., & Sachs, R. K. (1974). The Large Scale Structure of Space-Time. *Physics Today*, 27(4), 91–93. <https://doi.org/10.1063/1.3128542>

Throne, K. S. (1993). Closed Timelike Curves. A *Caltech Goldenrod Preprint in Theoretical Astrophysics or Gravitational Physics*. Published.

\*\*\*