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The 4-Dimensional Spacetime World Line Image Representation and the Law of Existence of Objects Inferred from it

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ABSTRACT

MINKOWSKI defined the four-dimensional spacetime model (x, y, z, t) used to represent world-point and world in [1]. The spacetime light cone is an intuitive diagram, compacted one space component and replaced it by time axis, thus the spacetime light cone was based on (x, y, t). In such a way, although it made the visual expression is possible, but also the spacetime light cone exposed shortages as follows

- The spacetime light cone has limited expressive ability
- The relationship between two or more world lines or events cannot be expressed
- Can't express different world lines correctly
- Most images of spacetime light cones are wrong and no use
- The image of spacetime light cone is not intuitive and is obscure in application.

Because of this, we designed the 4-dimensional Spacetime World Line image representation. This new 4-dimensional Spacetime diagram presents the complete 3 space dimensions and 1 time dimension. It overcomes the weakness of spacetime light cone, gives clear and precise visual expression of the world line, is able to display multi-world lines in one figure, can clearly present the interface and development process of each of the world line, and display the interaction among them.

From the 4-dimensional spacetime diagram, we deducted and proved the Law of Existence of Object, which is as such: From its birth, through its past, to the present, and into the future, an **object only exists at the "present" moment**.

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Introduction

MINKOWSKI defined the four-dimensional spacetime model (x, y, z, t) used to represent world-point and world in [1]. The spacetime light cone is an intuitive image drawn according to the world-point and world defined by MINKOWSKI in [1]. However, since humans can only draw three-dimensional images, the four-dimensional spacetime was compresses into three-dimensional, with the Z axis of the space in the three-dimensional space (X, Y, Z) being replaced by the time axis T. So, there is a three-dimensional visual spacetime model (x, y, t).

The invention of the light cone diagram is to more intuitively understand and express the concepts related to the spacetime light cone through graphics. But the actual situation is just the opposite: the defect of the spacetime light cone diagram makes it not achieve the purpose of intuitively displaying or understanding the related concepts.

In summary, the defects of the spacetime light cone have the following points

1) The spacetime light cone has limited expressive ability
1 light cone can only express one event.

2) The relationship between two events cannot be expressed
If we need to study two events or world-lines that affect each other, the light cone has no way to express them.

3) Can't express different world lines correctly
For example: below there are N curves that are different in 3D space
$X = x$,
$Y = y$,
$Z = K_i (x + y)$, $K_i = 1, 2, 3, ..., N$
When the Z-axis is replaced by the time axis T, these curves become as following:
$X = x$
$Y = y$
$T_i = t$, $i = 1, 2, 3, ..., N$
All these N curves become exactly the same in (X, Y, T) spacetime.

4) Most images of spacetime light cones are wrong and useless
The future light cone in the spacetime light cone has not happened yet, and actually does not exist. The light cone in the future is just

an estimate of the maximum range of light that can propagate. It is exactly the same for any future light cone of other events, with little intuitive meaning. And, the event may stop at the "present" moment, so the light cone will not appear or exit in the future.
The past light cone in the spacetime light cone, as MINKOWSKI said, is "the front cone of O, consists, let us say, of all the world-points which send the light to O" [1-5]. The light emitted by any world-point will only diverge with the elapse of time, and will not converge to point O. And the light emitted from a big portion of world-points cannot reach the O point.

5) The image of spacetime light cone is not intuitive and is obscure in application
The image of the light cone is obscure and difficult to understand. Even experts often make various mistakes in application.

On this point, we use Stephen Hawking's description of the light cone in [6] and [7] to illustrate this problem.

In [6], Mr. Hawking explained in detail the incident light cone as follows
"The light spreading out from an event forms a (three-dimensional) cone in (the four-dimensional) spacetime. This cone is called **the future light cone** of the event. **In the same way**, we can draw another cone, called the **past light cone**, which is the **set of events** from which **a pulse** of light is able to reach the given event."

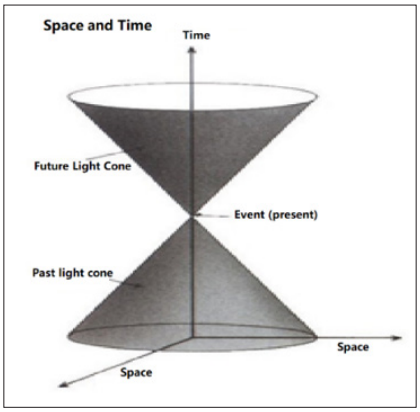


Figure 1: Spacetime Light Cone (from Figure 2.4 of [7])

Obviously, the last half sentence is somewhat wrong and vagueness meaning. So people often skip it. Thus, the past light cone is obtained "in the same way," which is the way the light of the Event at present sending light to future. In such way, the light is sent from the present to the past. This brought the time travel into the science. Since "The Brief History of Time" is a very famous popular book, the time travel concept was spreading fast in name of science since then.

13 years later, Mr. Hawking described the past light cone in detail in his new book [7]. This time he removed the above vagueness and corrected. But still he left lots of points to be discussed. Let's see following figure copied from that book.

In Figure 2, every circled text label has problem to be discussed. For one example, the label ② means "Galaxies as they appeared recently," and the label ③ means "Galaxies as they appeared 5 billion years ago", so Mr. Hawking believes that the galaxies indicated by ② is closer to the observer's "present" than the galaxies indicated by ③. But this is wrong. "Galaxies as they appeared 5 billion years ago" can also be located very close to the observer, such as the Sun; "Galaxies as they appeared recently" can also be located very far, such as a galaxy's age is 5 billion and 20 years old, and locates at 5 billion light-years away from the observer. Its light only appeared 20 years ago to the observers. There is also the famous 30-year-old young black hole located 5 million light-years away from the observer (of course this is completely wrong) [8]. It can also explain that the image of the light cone is not a clear concept.

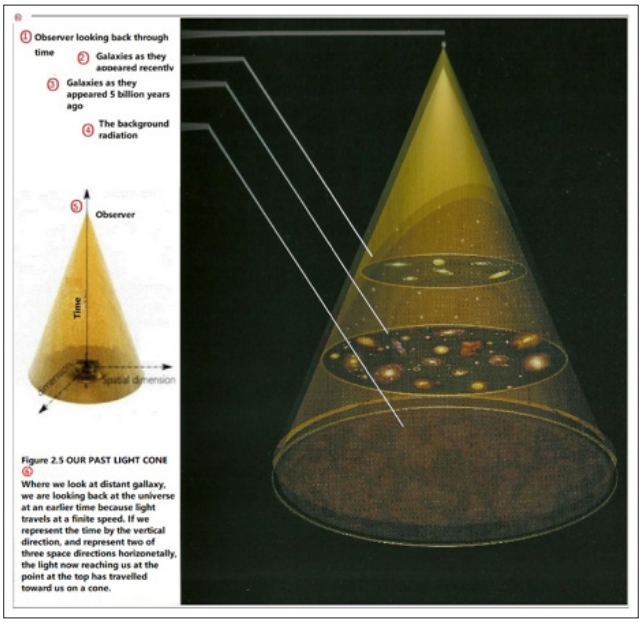


Figure 2: Hawking's Past Light Cone and its Interpretation. (The original Figure 2.5 in his book <The Universe in A Nutshell>.) The text label on the left of the figure are explanations for the figure on the right, and the right part of the figure is the past light cone with some galaxies drawn. The explanatory labels are for the small images of the right-side figure. I added those circled numbers ①, ②, ..., ⑥ in front of the labels to make it easier to explain.

Even big master like Mr. Hawking was confused by the light-cone, which is the visualized representation for the world line in spacetime theory. So, we should consider a more clear and intuitive way to display the spacetime concept. This is our discussion below.

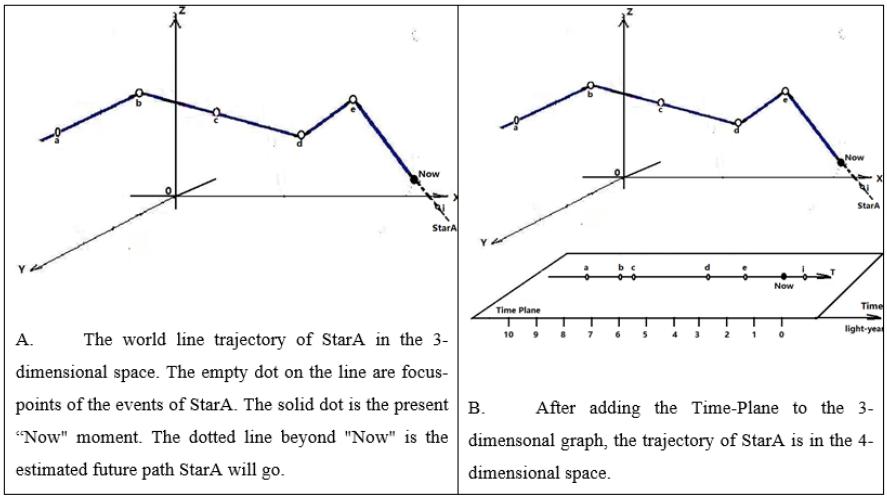
4-Dimensional Spacetime Diagram Expression of the World Line of the Event Object
MINKOWSKI said in [1]
"Let x, y, z be rectangular co-ordinates for space, and let t denote time.

But I still respect the dogma that both space time have **independent** significance.
it is only in four dimensions that the relations here taken under consideration reveal their inner being in full simplicity, and that on a three-dimensional space forced upon us a priori they cast only a very complicated projection."
All of the above statements have become our basic principles for designing world-line image representations in 4-dimensional spacetime.
1) In the left frame of Figure 3 below, the trajectory of StarA is drawn in the 3-dimensional space. The empty dot on the line are focus-points of the events (or objects) of StarA. The solid dot is the present "Now" moment. The dotted line beyond "Now" is the estimated future path StarA will go. The **focus-points** are numbered sequentially from beginning of the world line to the

"Now" moment of the world line. Beyond is the future, which does not exist. So, this dotted line is only an estimate of the StarA perhaps would go.

2) In the right frame of Figure 3, the independent Time-Plane is added to the 3-dimensional space, thus constructed a 4-dimensional spacetime diagram, The Time-Plane has a Time axis with the time unit used for StarA. Inside the Time-Plan there is a Time axis for world line of StarA. On this axis a series of empty circle dot numbered sequentially from the starting of the event to the "Now" moment, and extends to the future we are interested. All of them are corresponding to the focus-points of the world line, and has same number for each. In such a way, not only the independent of the time and space is kept, but also the relationship between the space and time is clearly presented.

The result is shown in Figure 3 below.



A. The world line trajectory of StarA in the 3-dimensional space. The empty dot on the line are focus-points of the events of StarA. The solid dot is the present "Now" moment. The dotted line beyond "Now" is the estimated future path StarA will go.

B. After adding the Time-Plane to the 3-dimensonal graph, the trajectory of StarA is in the 4-dimensional space.

Figure 3: From the 3-dimensional space to the 4-dimensional space

In Figure 4, three world lines were displayed. We can clearly see the relationships among them. We also can clearly see the process of the time effect on each of the world line.

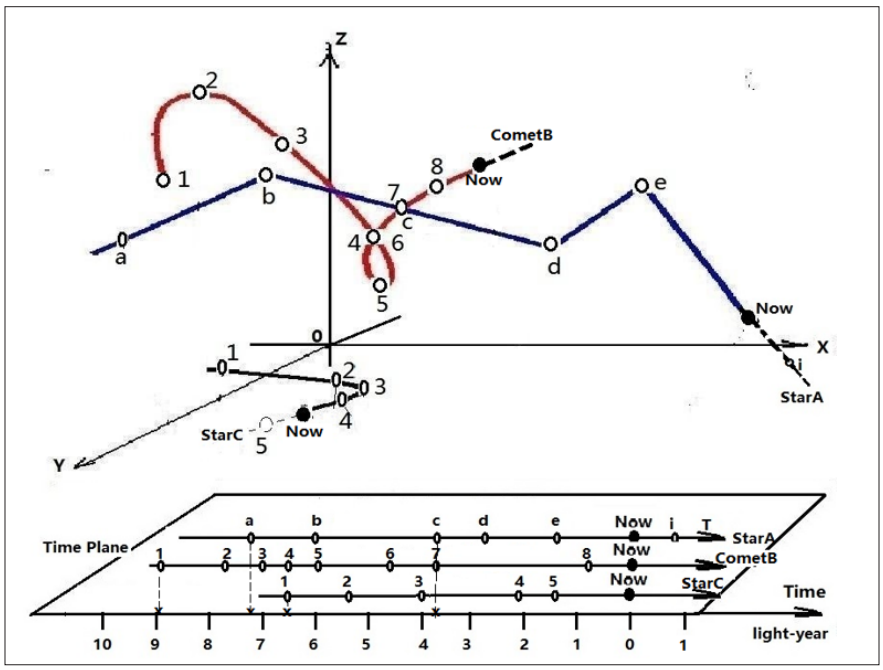


Figure 4: 3 world lines" StarA, CosmetB, StarC" in a 4-dimentional spacetime diagram. We cam see the complicated trajectories and related time frame of these world lines

The focus-points on StarA are labeled a, b, c, d, e; on CometB are labeled 1, 2, ..., 8; and on StarC are labeled 1, 2, 3, 4. The present of the worldlines are labeled "Now," and the focus-points in future after "Now" are independent from other focus-points.

The lower panel of Figure 4 is the Time-Plane, in which we draw a time axis for each world line. The "Now" point of these time axis are lined at the same position. We can see the starting time for each object is not the same. And we also can see that focus-point c on StarA is overlapping focus-point 7 of CometB, which means Star A was meeting Comet B at that time shown in Figure 4.

We also can see the overlap of focus-points 4 and 6 on CometB. From time axis for CometB we can see this means the comet traveled back the same location years later.

If we represent everything or every single object in the world with a world line, from the set of all these world lines, we can reason out the related Law of Existence of Objects. Here "object" denotes "event, substance or light."

The Law of Existence of Objects

The definition of the **Law of Existence of Objects**: From its birth, through its past, to the present, and into the future, an **object only exists at the "present" moment**.

The past of an object is the memory of the sequential incidents the process of the object's evolution left us. The relative future of an object consists of events with respect to the object that have already happened, but the information is transmitting to the destination and has not yet been received, and the process of this event is ordered and is irreversible. The absolute future of an object does not exist at this "now" moment but only as a prediction or expectation of object events at specific future moments. Watch something external to the system from any place to see the object itself exists only in the corresponding system itself at the "Now" moment. All the rest occurred in the history of the event recorded before this "Now" moment, and events after this "Now" moment do not exist, cannot be seen, and possibly might happen in the future. Things can be broken down as well as combined.

This is the existence of objects theorem, referred to as the existence theorem.

I will now define the new concepts of relative future and absolute future. For example, working in the city, Peter wrote a letter to his wife at home. When this letter was put into the mailbox, "Peter's wife is getting a letter from Peter" became a relative future event to his wife because he has written the letter but it has not yet made it to the hands of the recipient. If Peter has not written the letter, then " Peter's wife is getting a letter from Peter" is the absolute future because it has not happened yet. But we know that based on the historical record, there is a big possibility that it will happen under normal circumstances.

The relative future is what has happened, but the information about the happened event has not been transmitted to the recipient. If there is no problem with the transfer process, the event finally occurs, but there is a possibility that it may not occur. If Peter wrote a letter to his wife, the event of "Peter's wife is getting a letter from Peter" becomes a relative future event. But it is also possible that Peter's letter will be lost in the delivery process and the event of "his wife is receiving the letter" will not occur.

The absolute future belongs to the event that did not happen. Peter has not written the letter yet. In the future, it is also likely to occur, or it may not occur.

The concepts of relative and absolute future are important when discussing the issues of the universe. The sunlight emitted five minutes ago, to the observer on Earth, is a relative future event because it will be received and observed on the Earth three minutes later. The sunlight emitted 10 minutes later is the absolute future even to the observer on Earth. We believe that the Sun will continue to exist after 8 minutes and continue to send Earth light; there is a large possibility that Earth people will receive the sunlight emitted 10 minutes later, but it has not yet become a reality. The Sun may have been destroyed at the ninth minute.

Visual Evidence of the Law of Object Existence

The law of object existence only explicitly introduces time coordinates into the definition of the existence of Parmenides.

In a person's life, you can draw a diagram with the unit of year.

This is a sequence chart from birth to death of a man. It should be drawn every 10 years like Figure 5 shows; that is, every 10 years, draw a picture. It's okay to paint inaccurately here. Suppose this person has lived 100 years. Then, in accordance with the above provisions, you need to draw 10 pictures to indicate the person's life.

If a picture is drawn each year, 100 pictures are needed.

Draw one picture per hour? Per minute? Draw a picture every second? Draw every 0.001 seconds? Every 0.0000000001 second? .....

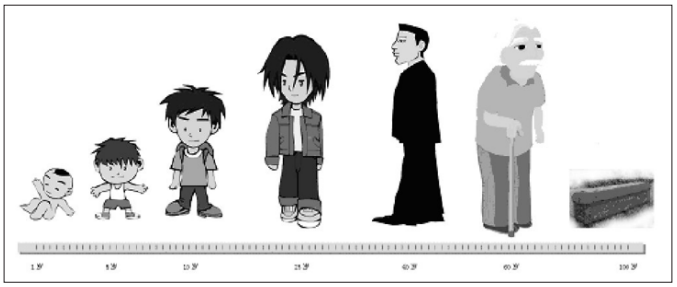


Figure 5: A man's whole life on display

At infinitely small intervals, of course, there will be unlimited images. This also means that a person's life can be an infinite number of snapshots. At every given moment, there is an entity that exists at that moment. And in that moment before or after the moment, the corresponding snapshot of the person has changed.

To make it clearer, let's magnify the snapshot interval of a snippet of a man's life.

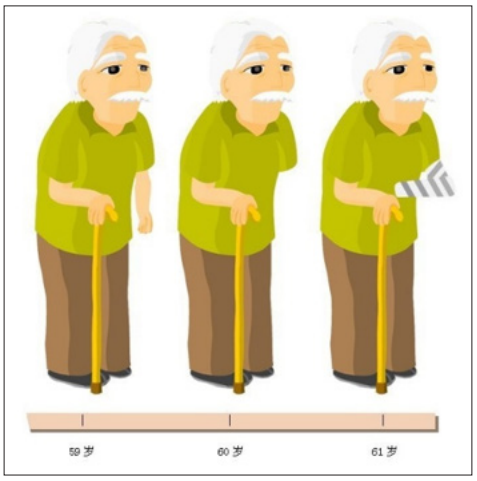


Figure 6: Schematic diagram of the time instances of "past, present, future" of a person's 60-year-old car accident

Mark any three moments (or any moment in the life of the person), such as 59, 60, and 61 or use x, x -1, x + 1 three arbitrary moments with x = 60. To put it more clearly, let's suppose this person had

a car accident and lost an arm at 60 years old. In that case, his 60-year-old status should be the middle figure with no arm, his status at 59 is normal, and his status at 61 is that he has a prosthetic.

What we should note is that according to the law of object existence, at the very moment when this person has lived to the snapshot of 60, the "he" indicated by the 59th snapshot has ceased to exist, and his good arms are just a memory of history in some form of photograph or video. In the snapshot of him at 61, he has lost his arm. But this event at 61 has not happened at the snapshot moment at 60. That's just a possible future condition of this person relative to the moment of the snapshot marked 60. At the moment when this person has lived to the snapshot at 60, or at a later time, we may speculate based on a variety of information, such as current medical standards, that it is probable that the individual will be alive at the moment of the snapshot at 61. If this person lost his arm during the Han Dynasty period, no new prosthetic limbs could be drawn on the snapshot; perhaps a stick would be attached.

This shows that a person's life consists of innumerable moments. But in every moment, people only exist at that moment!

The moment when the present moment exists, we call "the present."

In Haikou, I saw the past Buddha, the present Buddha, and the future Buddha. I just couldn't help but feel a great deal that the ancient Buddhists saw the world more thoroughly than some modern experts.

The Law of Object Existence Described by the World Line
A boat glides slowly in a calm lake. The boat is the point where the object now exists. The wave behind the ship is the path the ship ran and where the boat once existed in history. Where the front of the boat will reach in the future, we can probably calculate out, expecting when it will arrive according to the current position and trajectory history, but that has not happened yet. Perhaps, in the next moment, the boat will sink or change its direction.

The same reason and the same proof can be extended to everything we know in the universe.

Take, for example, the Sun. It is always creating and releasing energy, and it is not the same every moment.

Another example is the photon. One moment, it starts from the Sun, and the next moment, it is a few hundred thousand kilometers closer to us. And as it travels hundreds of thousands of kilometers, every place it passes through trajectory is only a moment of existence. The sum of all the existing moments constitutes the trajectory of the photon, that is, its world line. But the photon is not the world line; the photon is only one point. It is the unique operation of the photon trajectory that constitutes its world line; the track of each point corresponds to a different moment, and this photon is at the head of this world line.

The river is made up of numerous water droplets. Every moment, there is a lot of water flow into the sea, and the water from the source flows into the river. The river water always flows. The river is not exactly the same at any two moments.

The world line concept we are using here has a clear definition: an independent object represented in a world line, with the beginning of the world line corresponding to the event's starting position and time. The moment "now" corresponds to the world line forward vertex and is also the existence location of the object. All event points on the world line are strict, not chaotically arranged, from the beginning to the endpoint between the vertices, from the past to the present moment in an orderly sequence. Each point, in turn, is the expression of the state of the object event at that time, and from the moment they occur to now corresponds to each point on the timeline.

From the viewpoint of collections of objects, a planet can have its entire trajectory. The whole time, though, it only exists at the forward end of the trajectory; its past is the memory of the locations that it has moved through, and its future, based on expectations made from its past and present, does not exist in reality and is not shown in the figure. Of course, we can also draw "future" by the dashed line in the back vertex, behind the corresponding point time "Now" (more right) on the timeline.

A planet can be broken down into mountains, rivers, humans, animals, birds, insects, vegetation, and sediment... For every one of these, we can depict the individual based on knowledge of its world line. The forefront of the world line is the existence of the single individual at the current time "now." The collection of all of these separated individual objects' world lines is the planet's existence at time "now."

We can gradually and finely decompose, and also gradually polymerize, from large to small or small to large, but there is only one set of world lines, and their apexes represent the existence of the real objects!

When we call for spring in the winter of 2007, we expect the flowers of 2008. Spring is there year after year, but no one would say that flowers in 2008 spring are those that opened in 2007.

Summary

Because the four-dimensional space diagram cannot be expressed with images, the old spacetime light cone cannot achieve the purpose of describing the four-dimensional spacetime world line clearly and intuitively. Therefore, according to Minkovsky's description, we designed a four-dimensional space-time image representation that can accurately and intuitively represent multiple different world lines in one figure. In the process of observing the changes of multiple world lines in our four-dimensional space-time image, we discovered the Law of Existence of Objects. In this law, everything can only exist at the "Now" moment. This not only overthrows our inherent concept of material existence, but also makes non-scientific concepts such as time travel lose their foundation of existence.

References

1. Einstein, Lorentz HA, Weyl H, Minkowski H (1952) The Principle of relativity, Translated by W Perrett and GB Jeffery, Dover Publications, INC. Standard book number: 486-60081-5, 1952, "Space and Time" by H MINKOWSKI pp: 75-91.
2. Galion PL (1979) R McCormach et al., eds. Minkowski's Spacetime: from visual thinking to the absolute world. Historical Studies in the Physical Sciences 10. Johns Hopkins University Press. pp: 85-121.
3. Catoni F, Dino Boccaletti, Roberto Cannata, Vincenzo Catoni, Enrico N, et al. (2008) Mathematics of Minkowski Space. Frontiers in Mathematics. Basel: Burkhouse Verlag. doi:10.1007/978-3-7643-8614-6.
4. Corry L (1997) Hermann MINKOWSKI and the postulate of

relativity. Arch Hist Exact Sci (Springer-Verlag) 51: 273-314.
5. Yuxiang Wu (2020) Fading Modern Cosmology, Two-W Object. ISBN 9798645172633.
6. Hawking Stephen (1988) A Brief History of Time. Bantam Books. ISBN: 0-553-05340-X.
7. Hawking Stephen (2001) The Universe in a Nutshell, Bantam Books. ISBN: 0-553-80202-X.
8. NASA (2020) web site: https://www.nasa.gov/home/hqnews/2010/nov/HQ_10-299_CHANDRA.html.