

The Graphical Presentation of 4-Dimensional Spacetime World Line, and The Law of Existence of Objects Inferred from the World Line

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Abstract Since don't know how to draw a 4-dimensional graph, MINKOWSKI compressed his (X,Y,Z,T) model to (X,Y,T), and using spacetime light cone to represent 4-dimensional space graph. But such light cone brings lots of problems and errors. We showed some in the paper. To overcome that, we developed a new method to draw a real 4-dimensional spacetime graph. From the applying such method to draw multi-world lines in one graph, we were hinted to develop the Law of Existence of Objects: an **object only exists at the "present" moment.**

Introduction

The light cone has many drawbacks^[5] and even errors. Below is one example shows that the light cone can't express different world lines correctly:

There are N curves that are different in (X, Y, Z) 3D space, they are

$$X = x, Y = y, Z = K_i(x + y), \quad K_i = 1, 2, 3, \dots, N$$

When the Z-axis is replaced by the time axis T, these curves in (X, Y, T) space become as following:

$$X = x, Y = y, T_i = t, \quad i = 1, 2, 3, \dots, N$$

All these N curves become exactly the **same** in (X, Y, T) spacetime graphic.

Also, the light cone application is difficult to understand. Even experts make mistakes in applications. Let's take Stephen Hawking's description of the light cone in his books to see this problem.

Stephen Hawking misunderstood the spacetime light cone. In his book **"The Universe in a Nutshell"** he explained again the past light cone 13 years later, but still full with errors: (see **right side Figure 1**).

Every circled text label has problem to be discussed^[5]. For example, the figure shows that he believes that the galaxies indicated by ② is closer to the observer's "present" than the galaxies indicated by ③. But this is wrong.

"③. Galaxies as they appeared 5 billion years ago" can also be located very close to the observer, such as the **Sun**;

"②. Galaxies as they appeared recently" can also be located very far away. For example, 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.

All above can explain that the **light cone cannot** help people to know the spacetime concept **intuitively**. We **need** a better method to intuitively represent the 4-dimensional spacetime.

A New 4-dimensional spacetime drawing for the world line of the event object

Figure 2. Upper part is the 3 World line trajectories in (X, Y, Z) space for StarA, CometB, and StarC. The **Time-Plane** is added to the lower part. And 3 Time axis for each world line is added in the Time-Plane. In such a way, we kept the space and time have **independent** significance, but revealed their relationship. Figure 2. Upper part is the 3 World line trajectories in (X, Y, Z) space for StarA, CometB, and StarC. The **Time-Plane** is added to the lower part. And 3 Time axis for each world line is added in the Time-Plane. In such a way, we kept the space and time have **independent** significance, but revealed their relationship. Pay attention to focus-points 4 and 6 of CometB, means the CometB came to the same location in different times. Event 7 of CometB and Event C of StarA overlapped at the same time.

"Now" of all world lines are at the **same moment**. This gave us a hint of the **Law of Existence of Objects**.

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.**

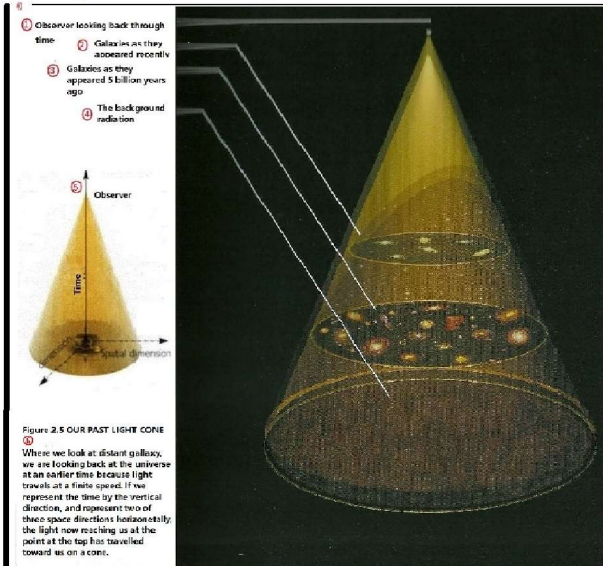
Summary

Spacetime Light cone **cannot** describe 4-dimensional spacetime world line correctly and intuitively.

Our 4-dimensional space-time graphical method 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.**



Stephen Hawking's book "The Universe in a Nutshell"

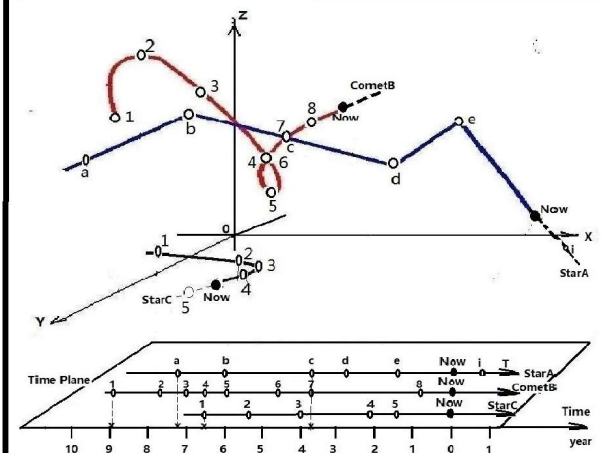


Figure2. An application example: 3 World line trajectories in (X, Y, Z, T) spacetime. Pay attention to focus-points 4 and 6 of CometB, means the CometB came to the same location in different times. Event 7 of CometB and Event C of StarA overlapped at the same time. "Now" of all world lines are at the same moment.

Major References:

- [1] Einstein, H.A. LORENTZ, H. WEYL, H. MINKOWSKI, THE PRINCIPLE OF RELATIVITY, Translated by W. PERRETT and G.B. JEFFERY, DOVER PUBLICATIONS, INC. Standard book number: 486-60081-5, 1952. p.p. 75-91, "Space and Time" by H. MINKOWSKI
- [2] Galiou, P. L. (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. doi:10.2307/27757388.
- [3] Catoni, F. et al. (2008). Mathematics of Minkowski Space. Frontiers in Mathematics. Basel: Burkhouse Verlag. doi:10.1007/978-3-7643-8614-6. ISBN 978-3-7643-8613-9
- [4] Corry, L. (1997). "Hermann MINKOWSKI and the postulate of relativity". Arch. Hist. Exact Sci. (Springer-Verlag) 51 (4): 273-314. doi:10.1007/BF00518231. ISSN 0003-9519.
- [5] Yuxiang Wu, (2020), *Fading Modern Cosmology*, Two-W Object, ISBN 9798645172633
- [6] NASA web site: https://www.nasa.gov/home/hqnews/2010/nov/HQ_10-299.CHANDRA.html, "NASA'S Chandra Finds Youngest Nearby Black Hole," retrieved on June 6, 2020
- [7] Hawking, Stephen W., *The Universe in a Nutshell*, Bantam Books, ISBN: 0-553-80202-X, 2001