

BIG BANG TO THE BIG RIP

by

Gary Heartsill

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*“If all mathematics, disappeared today,
physics would be set back exactly one week...
This was the week that God created the world”*

(lecture by Dijkgraaf).

Reason for this paper

This paper is a continuation of the previous notes on Einstein's Theory of Relativity where we looked at his 1916 book and discussed the railroad car and the two strikes of lightning to give credit to his "Relativity of Simultaneity."

This paper is a continuation from his Theory of Special Relativity to his Theory of General Relativity – actually this paper will pick up where a couple of current scientists and an experimental physicist have extended Einstein's theories. As a matter of fact. I want to use the input of these scientists to declare (and show) that they have a picture or a timeline of the cosmos.

This paper will just show the direction for seeing this timeline and discuss some of the issues of where an 'interested student' can see for himself just how Einstein predicted what he did.

Therefore, this paper will show or point out some current work on the 13.7 billion years of our universe.

My method is short. Not a whole lot of explain. I have the references for you to look at, to see, and to appreciate, where we are today.

This paper again honors Albert Einstein for the genius he was and to say thanks to the scientists expanded the knowledge.

Hope you enjoy the trek!

Background

My methodology is to point out and reference some books, videos, and papers which will be a shortcut to get on top of some information on The Big Bang and The Big Rip. Of course, this is just short a short presentation. There is a ton of information on this topic.

I will list again some books on Einstein but will add information on a college course, a video documentation, and some pictures from both.

In the end you shall have a picture of THE Timeline from the Big Bang to the present.

In the end you will have an idea of where to go, "to get into the ~~weeds~~ stars" with this 13.7 billion years.

In the end you won't have covered much – this can go on forever...not a bad thing.

Again, you know about bolts of lightning and the Special Theory so you will be able to say

"Now I have the big picture."

Let's first look at a black and white timeline:

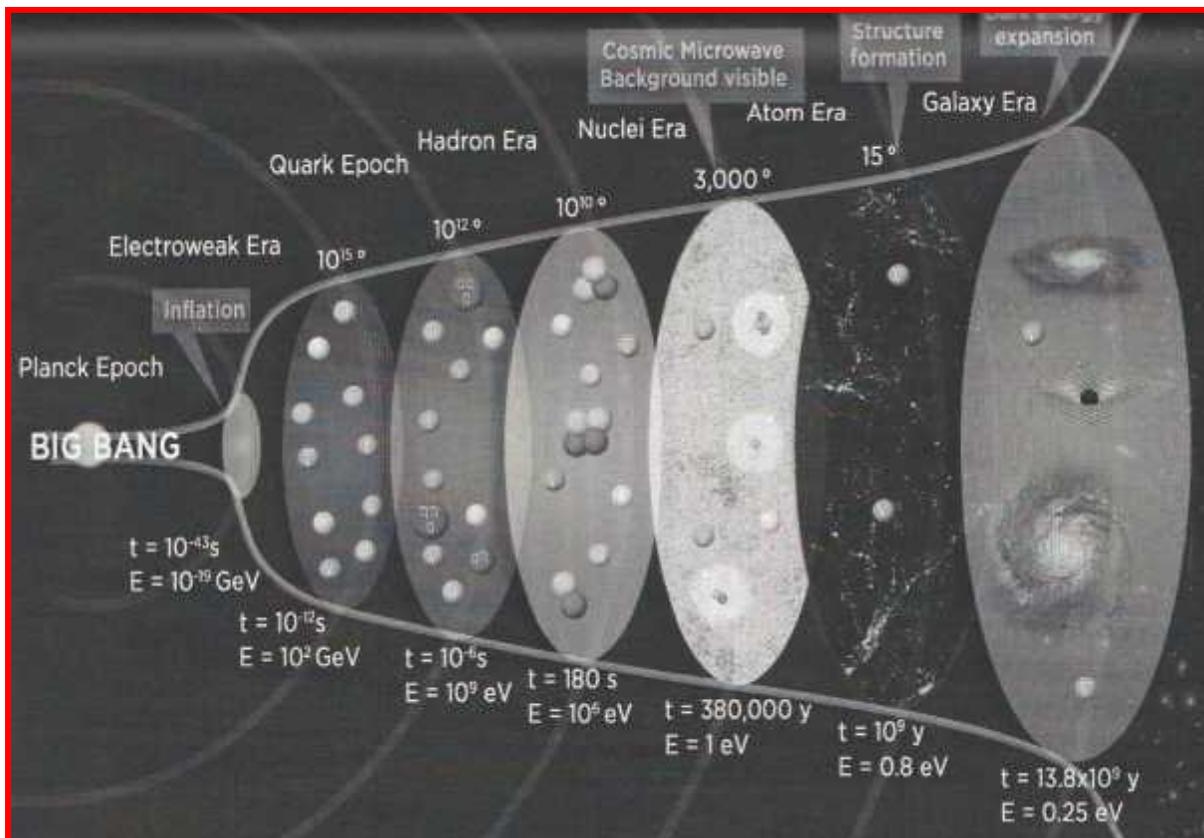


Figure 1. Timeline from The Teaching Company Collection, p. 479.

The BIG BANG is on the left and the right edge is 13.7 billion years of the expanding timeline. “It was born in a primordial fireball about 14 billion years ago” (Lincoln, p. 482).¹

Note the time line starts NOT before the Big Bang but “is everything after time equals ZERO.”

“The details are not known, but scientists believe about $t = 10^{-34} \text{ s}$ (seconds) after the big bang is a reasonable starting point” (Lincoln, p. 485) – this is **time equals 10 to the minus 34 seconds**. The $E = 10^2 \text{ GeV}$ is the energy regime in **electron volts**. At the top is temperature and show the range of really hot – at Electroweak Era of **10¹⁵ Celsius**.

About the fourth over or the Nuclei Era you see the Cosmic Microwave Background (CMB) visible. “From the period from 3 minutes (shown as $t = 180 \text{ s}$ - or seconds) to **380,000 years** after the universe began, it was too hot for atomic matter to form. But just shy of 400,000 years after our story started, the universe had cooled to about **3,000 degrees** Centigrade and the energy had dropped to about a single electron volt or **E = 1eV** (p. 491).

As you can see by my examples here, they come from “The Great Courses” in physics.

Note: just for drill, **the speed of light is 3×10^8 meters per second**.

¹ Don Lincoln (2017). *The theory of everything: The quest to explain all reality*. Chantilly, VA: The Great Courses.

One of the most intriguing lectures² or briefings I have watched is by Professor Robbert Dijkgraaf. The quote to open this paper is from his lecture (about 50 minutes). His title is *The End of Space and Time?*

You will be pleased to watch, download, or study this unique lecture.

At about 12:21 in his presentation you will see him quickly discuss the ‘history of the universe’ as the picture will show what Einstein predicted under “Big Bang Expansion.”

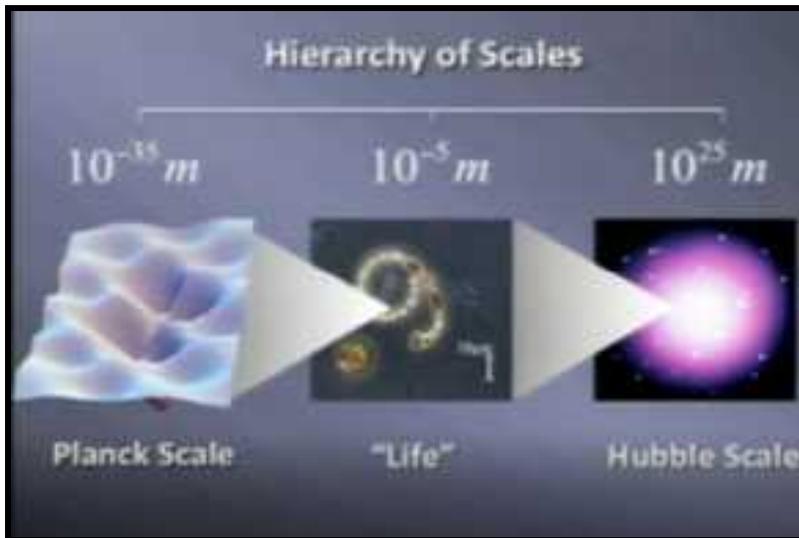


Figure 2 From the Dijkgraaf lecture.

This shows the range or hierarchy of scales from the beginning to at least the Hubble findings in 1929.

Note this range and compare it to the timeline in Figure 1.

10^{-35} m 10^{-5} m 10^{25} m

So, how long in time is it from the left to the right?

² Robbert Dijkgraaf (2012). A Gresham College production on 20 March 2012.
<https://www.gresham.ac.uk/lectures-and-events/the-end-of-space-and-time>

Let me suggest, if you want to have this available to look at and study, download as an MP4 on your computer. The ease in stopping, taking notes, or just listening is easier than seeing it online.

FROM THE BIG BANG TO THE BIG RIP – some key items

SPACE

TIME

FOURTH DIMENSION

GRAVITY = CURVATURE OF SPACE-TIME

MASS = ENERGY

EINSTEIN’S BIGGEST BLUNDER

HUBBLE, 1929

COSMIC MICROWAVE BACKGROUND (CMB)

IS THE UNIVERSE FLAT?

COSMIC INFLATION

DARK MATTER

DARK ENERGY

BLACK HOLES IN STRING THEORY

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HIGGS FIELD

LARGE HADRON COLLIDER (LHC)

LIGO – Feb 2016

The Big Rip

Dark energy will cause the expansion of the universe to accelerate. The very distant galaxies will move faster away from us...when this happens they will disappear “and we will never see them again...This phenomenon is called the big rip” (Lincoln, p. 415).

Before this happens:

To put a “AMEN” to this let me leave you with a printed piece – one you can print that is – of our timeline.

The last page is an expanded Figure of the first black and white timeline.

You have learned about railroad cars, lightning, and relativity. This next page will be something you can add to this learning and be able to say:

Here is our timeline from 10^{-35} m to 10^{25} m.

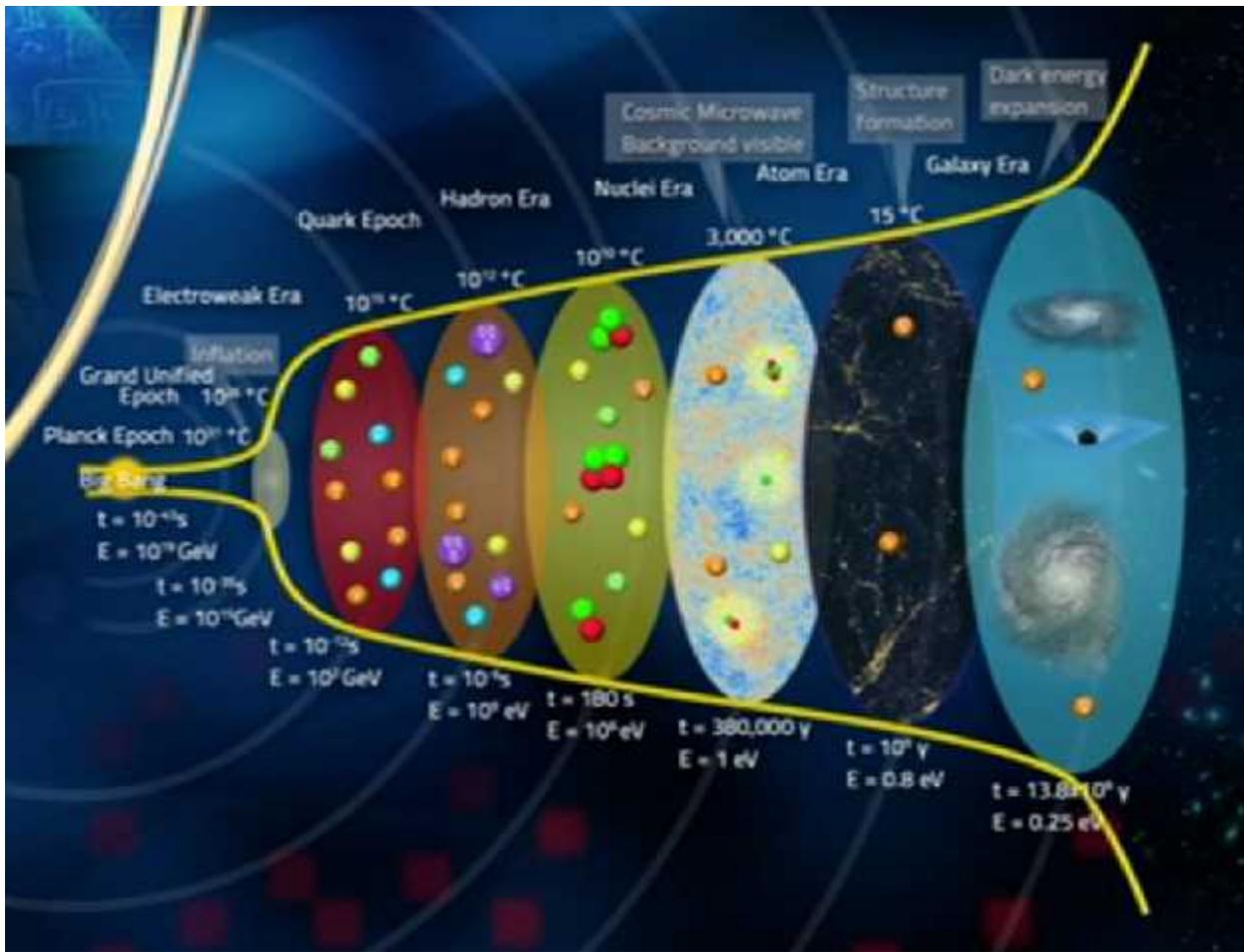


Figure 3. Print screen of Timeline in Lincoln's video course Lesson 22 in "The Theory of Everything."

- end³ -

³ Don't forget this video of Einstein:
The Extraordinary Genius of Albert Einstein - Full Documentary HD
<https://www.youtube.com/watch?v=Uypw6Jh1WGO>