SCIENCE SET
OPEN ACCESS PUBLISHERS

Review Article

Journal of Material Sciences & Applied Engineering

# The Light-Year

**Mathlouthi Adel**

*University of Tunisia, Tunisia*

[*]**Corresponding author:** Mathlouthi Adel, University of Tunisia, Tunisia.

**Submitted:** 01 January 2024 **Accepted:** 11 January 2024 **Published:** 20 January 2024

***Citation:*** *Mathlouthi Adel (2024) The Light-Year. J Mat Sci Apl Eng 3(1), 01-04.*

***Abstract***

*Using the light year as a unit of measurement helps to determine the age of the celestial bodies. When an object is observed from the earth one light year away, this means that we see it as it was a year ago, because according to the definition of the light year, it is the amount of light that the light travels in a year, i.e. how many It took a while for it to reach us, so when we say the Andromeda galaxy is 2.5 million years away from Earth, that means we're seeing what it was like 2.5 million years ago.*

*But is the duration of the earthly year at that time equal to the current time?*

*Can the speed of light be considered a universal constant?*

## Introduction

A light-year is a large unit of length used to express astronomical distances. As defined by the International Astronomical Union (IAU), a light-year is the distance light travels in space in one Julian year. Since it includes the chronometric word "year," the term light-year is misused sometimes interpreted as a unit of time.

The light year is often used when expressing distances to stars and other distances on a galactic scale, especially in non-specialized contexts and popular science publications.

Measuring in miles or kilometers with an astronomical scale is impractical given the scale of the numbers used. Starting in our cosmic neighborhood, the closest star-forming region to us, the Orion Nebula, is 1,300 light-years away. The center of our galaxy is about 27,000 light-years away. The nearest spiral galaxy to our own, the Andromeda Galaxy, is 2.5 million light-years away. Some of the most distant galaxies we can see are billions of light-years away from us. GN-z11 is believed to be the most distant galaxy detectable from Earth, at a distance of 13.4 billion light-years.

Like an accelerating top, the Earth is spinning faster and faster with each passing moment, making the years now shorter and shorter than they were in the past. When the planet rotates, water in the oceans moves around and acts as a brake on the planet's rotation. This is why the year is shorter than the year in the distant past. A past when water covered all the surface of the earth, fossils marine animals in the desert tell us that the earth was covered with water and fossil coral reefs are silent witnesses to the acceleration of the years.

## Problem

The measurement in light years also allows astronomers to determine the time period they are viewing. Because light takes time to travel to our eyes, everything we see in the night sky has already happened. In other words, when you observe something a light-year away, you see it as it appeared exactly one year ago. We see the Andromeda Galaxy as it appeared 2.5 million years ago.

But in that period, did the earthly year have the same accuracy as the year in modern times?

And was the light in that period the same speed as we know it today?

Whether light-years are fixed or not, astronomers will continue to use them to measure distances in our vast universe.

**Physics Equations and Formulas**

$E = mc^2$.

$A_{\text{current}} = \frac{c^2 \times \sqrt{m}}{t}$.

$V_{\text{tension}} = \sqrt{m}$.

$w_{\text{Power}} = \frac{E}{t} = \frac{mc^2}{t} = \text{current} \times \text{tension}$.

Elementary charge: $e = 1.602176634 \times 10^{-19}$ c

G: the gravitational constant = $6.67408 \times 10^{-11}\, m^3 Kg^{-1} S^{-2}$

C: Speed of light

The fine structure constant $\alpha = 7{,}2973525664 \times 10^{-3}$

The Dirac's constant $\hbar = 1{,}054571818 \times 10^{-34}\, J.s$

The Planck's constant $h = 6{,}6260702 \times 10^{-34}\, J.s$

**The Quantum Current**

The quantum current it is, in the unit of quantum black hole measurement system, the unit of electric current (1),

$$\text{Quantum Current} = \frac{2\times\pi\times e^2}{\alpha} \times \sqrt{\frac{4\times\pi\times\varepsilon_0}{c^3\times\hbar}} = 4{,}\ 3691269\times10^{-36}\text{A}$$

**Radiation era in the end of the Triassic Period about 199 Million Years**

The Triassic–Jurassic extinction event marks the boundary between the Triassic and Jurassic periods, and is one of the major extinction events of the Phanerozoic eon, profoundly affecting life on land and in the oceans. In the seas, a whole class and 23–34% of marine genera disappeared [1-3].

$$\text{End of the Triassic era} = \frac{\alpha \times \hbar \times c^2}{2 \times \pi \times e^2} = 4.2942106 \times 10^{17}\ seconds$$

=13607904963.1 years after big-bang

**The Lifetime Equation**

Universe mass in the end of the Triassic era about 199 million years (1) (2) (3) (4)

$$mass_{universe} = \frac{\alpha \times c^5 \times \hbar}{e^2 \times (2\pi) \times G} = 1{,}7367754 \times 10^{53} Kg$$

$$= \frac{planck\ tension^2}{2\pi}$$

$V_{\text{tension}} = \sqrt{m}$.

$w_{\text{Power}} = \frac{E}{t} = \frac{mc^2}{t} = \text{current} \times \text{tension}$.

$A_{\text{current}} = \frac{c^2 \times \sqrt{m}}{t}$.

$$the\ lifetime = \frac{c^2}{\text{quantum current}} \times \sqrt{\frac{mass}{(2\pi)}}$$

**The Lifespan, Peak Mass and Peak Time of the Photon**

The idea that photons have a finite lifespan, and therefore mass, is difficult to imagine. Indeed, astronomers looking at distant cosmic objects regularly detect photons that are billions of years old. But some theories suggest that photons could have a non-zero rest mass, albeit a small one – the upper limit for the mass of the photon is constrained to thanks to experiments with electric and magnetic fields. And with this small mass, a photon could decay into other lighter elementary particles, such as a pair of the lightest neutrino and an antineutrino, or even particles that are currently unknown and beyond the Standard Model of particle physics [2].

- **The Photon Lifespan**

$$\frac{c^2}{\text{quantum current}} \times \sqrt{\frac{mass_{Photon}}{(2\pi)}} = \frac{2\times\pi\times\hbar\times c^2}{\alpha\times e^2} = 3.1839973 \times 10^{23}\ seconds =$$

$1{,}0089755 \times 10^{16} years\ after\ big-bang$ (2)(3)

- **The Photon Peak Mass (End of the Triassic Era about 199 Million Years):**

$$\text{Photon mass} = \frac{32\times\pi^4\times h\times\varepsilon_0}{\alpha^4\times c^3} = 2.3885215 \times 10^{-58}\text{Kg}$$

- **The Photon Peak Time:**

$$\frac{\alpha^5 \times c^5 \times mass_{photon}}{128 \times \pi^6 \times e^2 \times \varepsilon_0} = \frac{8 \times \pi^2 \times h^2 \times \varepsilon_0}{\alpha^3 \times e^2 \times c \times mass_{photon}} =$$

$$\frac{\alpha \times \hbar \times c^2}{2 \times \pi \times e^2} = 4.2942106 \times 10^{17}\ \text{seconds}$$

= 13607904963.1 years after big – bang (End of the Triassic era about 199 million years),

**Redefinition of the SI Base Units**

In 2019, four of the seven SI base units specified in the International System of Quantities were redefined in terms of natural physical constants, Effective 20 May 2019, the 144th anniversary of the Meter Convention, the kilogram, ampere, Kelvin, and mole are now defined by setting exact numerical values, when expressed in SI units, for the Planck constant, the elementary electric charge, the Boltzmann constant, and the Avogadro constant, respectively. The second, meter, and candela had previously been redefined using physical constants. The four new definitions aimed to improve the SI without changing the value of any units, ensuring continuity with existing measurements. In November 2018, the 26th General Conference on Weights and Measures (CGPM) unanimously approved these changes, which the International Committee for Weights and Measures (CIPM) had proposed earlier that year after determining that previously agreed conditions for the change had been met. These conditions were satisfied by a series of experiments that measured the constants to high accuracy relative to the old SI definitions, and were the culmination of decades of research [5-8].

As of May 20, 2019, this day will be the reference for calculating the characteristics of the photon.

**The Natural Physical Constants (May 20, 2019)**

As of May 20, 2019, the SI base units defined in the International

System of Quantities have been redefined in terms of natural physical constants,

Elementary charge: $e = 1.602176634 \times 10^{-19}$ C.

G: the gravitational constant = 6.67408$\times 10^{-11}\ m^3 Kg^{-1} s^{-2}$.

C= 300000000 $^{m}/_{s}$ .

$Ç = \frac{e^2}{\alpha \times 4 \times \pi \times \hbar \times \varepsilon_0} = 299792457{,}928\ ^{m}/_{s}$ . (May 20, 2019)

The fine structure constant $\alpha = 7{,}2973525664 \times 10^{-3}$.

The Dirac's constant $\hbar = 1{,}054571818 \times 10^{-34}\ J.s$

The Planck's constant $\mathrm{h} = 6{,}6260702 \times 10^{-34}$ J. s

Vacuum permittivity: $\varepsilon_0$= 8.85418781762039$\times 10^{-12}\ Kg^{-1} n$

**The age of the Universe (May 20, 2019)**
**On this day, the age of the universe is:**

$$\frac{\alpha \times ç}{4 \times \pi^2 \times \varepsilon_0} = \frac{e^2}{8 \times \pi^2 \times h \times \varepsilon_0^2} = \frac{\alpha^2 \times ç^2 \times \hbar}{e^2 \times \pi} = 6{,}2586053 \times 10^{15} s$$

$$= 198328665{,}11 \text{years after the Triassic} - \text{Jurassic extinction,}$$

$$\left(\frac{\alpha \times c^2 \times \hbar}{e^2 \times (2\pi)}\right) + \left(\frac{\alpha^2 \times ç^2 \times \hbar}{e^2 \times \pi}\right) = \frac{\alpha \times c^2 \times \hbar}{e^2 \times (2\pi) \times \sin(80{,}2767)} = 4{,}3567967 \times 10^{17} s$$

$$= 13806233487{,}7\ years\ after\ big - bang \quad (4)$$

- **The mass of the photon (May 20, 2019):**

$$m' = \left(\frac{32 \times \pi^4 \times \mathrm{h} \times \varepsilon_0}{\alpha^4 \times c^3}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4 \times ç^4}\right) = \left(\frac{32 \times \pi^4 \times \mathrm{h} \times \varepsilon_0}{\alpha^4 \times c^3}\right) - \left(\frac{96 \times \pi^4 \times \mathrm{h} \times \varepsilon_0}{\alpha^3 \times ç^3}\right)$$

$=2.3361232 \times 10^{-58}$Kg

- **J-The light-year (May 20, 2019):**

The speed of light:

$$ç = \frac{e^2}{\alpha \times 4 \times \pi \times \hbar \times \varepsilon_0} = 299792457{,}928\ ^{m}/_{s} .$$

$$mass'_{photon} = 2.3361232 \times 10^{-58} Kg.$$

$$\text{The light-year} = \frac{h}{mass'_{photon} \times ç} = 9{,}4606 \times 10^{15}\text{m.}$$

- **K-The light-year (End of the Triassic era about 199 million years):**

The speed of light:

$$ç' = \left(\frac{e^2}{2 \times \alpha \times h \times \varepsilon_0}\right) - \left(\frac{3 \times e^2}{2 \times h \times \varepsilon_0}\right) = 293229384{,}143\ ^{m}/_{s}.$$

$$mass_{photon} = \left(\frac{32 \times \pi^4 \times \mathrm{h} \times \varepsilon_0}{\alpha^4 \times c^3}\right) = 2.3885215 \times 10^{-58} Kg.$$

$$\text{The light-year} = \frac{h}{mass_{photon} \times ç'} = 9{,}4606174 \times 10^{15}\text{m.}$$

**How Many Seconds in a Triassic Year?**

The second is the basic unit of time, a core unit is a unit defined on its own terms on which other units are based. This means that all other units, such as minutes, hours, nanoseconds, etc., are all based on seconds. We talk about hours in terms of minutes, but minutes are built on seconds, which brings us back to the basic unit. The second was dependent on the Earth's rotation cycle, with one second being 1/86400 of a mean solar day. Now that we know more about how the Earth rotates - and that the speed at which it rotates is slowing down and accelerating according to geological ages (water moves in the oceans and acts as a brake for the rotation of the planet), where the slowdown is when water covers more than 75% of the Earth's area and the acceleration is when water covers Less than 65% of the planet's surface.

The Conventional Second will be the Basic Unit for Calculating the Length of the Year at the end of the Triassic Period.

The Length of the Year on Earth at the end of the Triassic Period:

$$\text{The day} = 24 \times \left(1 + \frac{e^2}{\hbar \times \varepsilon_0 \times ç'}\right) = 24{,}358 \text{ hours}$$

$$\text{The year} = \frac{\mathrm{h}}{\text{mass}_{\text{photon}} \times ç'^2} = 32263531{,}17 \text{ seconds}$$

$$= 367{,}93 \text{ days.}$$

**The Characteristics of the Photons (End of the Triassic era about 199 Million Years)**

$$\text{speed}_{\text{before decoupling}} = \left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\hbar \times G}{c^5}}\right) = 3{,}2911479 \times 10^{-42}\ ^{m}/_{s}$$

$$\text{speed}_{\text{after decoupling}} \left(\frac{e^2}{\alpha \times 4 \times \pi \times \hbar \times \varepsilon_0}\right) - \left(\frac{3 \times e^2}{4 \times \pi \times \hbar \times \varepsilon_0}\right) = 293229384{,}143\ ^{m}/_{s}.$$

$$\text{mass} = \left(\frac{32 \times \pi^4 \times h \times \varepsilon_0}{\alpha^4 \times c^3}\right) = 2.3885215 \times 10^{-58}\text{Kg.}$$

$$\text{Energy} = \left(\frac{64 \times \pi^5 \times \hbar \times \varepsilon_0}{\alpha^4 \times c}\right) = 2{,}1496694 \times 10^{-41}\text{ Jouls.}$$

$$\text{Force} = \left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\hbar \times c}{G}}\right) = 1{,}33143 \times 10^{-6}\text{ N.}$$

$$\text{Density} = \left(\frac{64 \times \pi^5 \times e^2 \times \varepsilon_0}{\alpha^5 \times \hbar \times G \times c^3}\right) = 7.112475 \times 10^{-15}\text{ Kg m}^{-3}.$$

$$\text{Pressure} = \left(\frac{64 \times \pi^5 \times e^2 \times \varepsilon_0}{\alpha^5 \times \hbar \times G \times c}\right) = 640{,}12275\text{Pa .}$$

$$\text{Curent} = \left(\frac{128 \times \pi^5 \times \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\pi \times \hbar \times \varepsilon_0}{c}}\right) = 3{,}8244898 \times 10^{-25}\text{A.}$$

$$\text{Tension} = \left(\frac{32 \times \pi^4}{\alpha^4} \times \sqrt{\frac{\pi \times \varepsilon_0 \times \hbar}{c^3}}\right) = 1{,}14576 \times 10^{-23}\text{V.}$$

$$\text{Momentum} = \left(\frac{64 \times \pi^5 \times \hbar \times \varepsilon_0}{\alpha^4 \times c^2}\right) = 7{,}1655645 \times 10^{-50}\text{N. s}$$

$$\text{Frequency} = \left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4 \times c}\right) = 2{,}0384286 \times 10^{-7}\text{Hertz.}$$

Mechanical impedance =

$$\left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\hbar}{c \times G}}\right) = 4.4381145 \times 10^{-15}\text{ Kg s}^{-1}.$$

$$\text{Linear density} = \left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\hbar}{c^3 \times G}}\right) = 1{,}4793715 \times 10^{-23}\text{Kg m}^{-1}.$$

**The Characteristics of the Photons (May 20, 2019):**

$$speed_{before\ decoupling} = \left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\hbar \times G}{c^5}}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4} \times \sqrt{\frac{G}{\hbar \times ç^7}}\right) = 3{,}2039367 \times 10^{-42}\ ^{m}/_{s}$$

$$speed_{after\ decoupling} = \left(\frac{e^2}{\alpha \times 4 \times \pi \times \hbar \times \varepsilon_0}\right) = 299792457{,}928\ ^{m}/_{s}$$

$$mass = \left(\frac{64 \times \pi^5 \times \hbar \times \varepsilon_0}{\alpha^4 \times c^3}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4 \times ç^4}\right) = 2.3361232 \times 10^{-58} \text{Kg}$$

$$\text{Energy} = \left(\frac{64 \times \pi^5 \times \hbar \times \varepsilon_0}{\alpha^4 \times c}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4 \times ç^2}\right) = 2{,}092765 \times 10^{-41} \text{ Jouls}$$

$$\text{Force} = \left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\hbar \times c}{G}}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4 \times \sqrt{G \times \hbar \times ç}}\right) = 1{,}29618 \times 10^{-6} \text{ N.}$$

$$\text{Density} = \left(\frac{64 \times \pi^5 \times e^2 \times \varepsilon_0}{\alpha^5 \times \hbar \times G \times c^3}\right) - \left(\frac{58 \times \pi^4 \times e^4}{\alpha^5 \times ç^4 \times \hbar^2 \times G}\right) = 6.9241991 \times 10^{-15} \text{ Kg m}^{-3}$$

$$\text{Pressure} = \left(\frac{64 \times \pi^5 \times e^2 \times \varepsilon_0}{\alpha^5 \times \hbar \times G \times c}\right) - \left(\frac{58 \times \pi^4 \times e^4}{\alpha^5 \times ç^2 \times \hbar^2 \times G}\right) = 623{,}1779231 \text{Pa}.$$

$$\text{Curent} = \left(\frac{128 \times \pi^5 \times \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\pi \times \hbar \times \varepsilon_0}{c}}\right) - \left(\frac{96 \times \pi^4 \times e^2}{\alpha^4} \times \sqrt{\frac{\pi \times \varepsilon_0}{\hbar \times ç^3}}\right) = 3{,}72225 \times 10^{-25} \text{A}$$

$$\text{Tension} = \left(\frac{32 \times \pi^4}{\alpha^4} \times \sqrt{\frac{\pi \times \varepsilon_0 \times \hbar}{c^3}}\right) - \left(\frac{29 \times \pi^3 \times e^2}{\alpha^4 \times ç^2} \times \sqrt{\frac{\pi}{\varepsilon_0 \times \hbar \times ç}}\right) = 1{,}11543003 \times 10^{-23} \text{V}$$

$$Momentum = \left(\frac{64 \times \pi^5 \times \hbar \times \varepsilon_0}{\alpha^4 \times c^2}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4 \times ç^3}\right) = 6{,}9758833 \times 10^{-50} N.s$$

$$\text{Frequency} = \left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4 \times c}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4 \times \hbar \times ç^2}\right) = 1{,}\ 98446892 \times 10^{-7} Hertz$$

Mechanical impedance =

$$\left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\hbar}{c \times G}}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4} \times \sqrt{\frac{1}{\hbar \times ç^3 \times G}}\right)$$

$$= 4.3206322 \times 10^{-15}\ Kg\ s^{-1}$$

$$Linear\ density = \left(\frac{64 \times \pi^5 \times \varepsilon_0}{\alpha^4} \times \sqrt{\frac{\hbar}{c^3 \times G}}\right) - \left(\frac{58 \times \pi^4 \times e^2}{\alpha^4 \times ç^2} \times \sqrt{\frac{1}{\hbar \times ç \times G}}\right)$$

$$= 1{,}4402107 \times 10^{-23} Kg\ m^{-1}$$

## Conclusion

Accurate and powerful telescopes are currently used to look at various distant objects in space, and in fact they allow scientists to look back in time, because light travels at a speed of 299792457,928 meters per second, and despite this imaginary speed, objects in space are very far away. Its light takes a lot of time to reach the earth, so the farther the celestial body is, the more scientists can see it in the distant past, in the past the time of the year on earth was not equal to the present time.

In the universe, all celestial bodies are accelerating or decelerating, from planets and stars to electrons and photons, but the light year remain a cosmic constant.

## References


1. Adel Mathlouthi (2022) Quantum Gravity Constants. To Physics Journal 9: 1-6.
2. Adel Mathlouthi (2022) the Theory of the Photon. Journal of Engineering and Applied Sciences Technology 4: 1-5.
3. Adel Mathlouthi (2022) the radiation eras. To Physics Journal 9: 1-6.
4. Adel Mathlouthi (2022) the Theory of the universe. Journal of Engineering and Applied Sciences Technology 5: 1-9.
5. Wikipedia/wiki/light-year
6. “BIPM statement: Information for users about the proposed revision of the SI” (PDF). Archived (PDF) from the original on 21 January 2018. Retrieved 5 May 2018.
7. “Decision CIPM/105-13 (October 2016)”. Archived from the original on 24 August 2017. Retrieved 31 August 2017.
8. “9th Edition of the SI Brochure”. BIPM. 2019. Retrieved 20 May 2019.