The Geometric Core of Spacetime

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Abstract— A pair of very basic geometric forms, when properly linked, identifies the union between space and time. Additionally, the paired triangles mathematically define the size of the most basic units of measure, a unit length and a unit time duration, and produces a mathematically defined value for the speed of light. One does not need to know ahead of time the actual physical size of the dimensions used to describe the elements of the triangles.

I. Introduction

How space and time are interrelated has consumed immeasurable hours of effort by philosophers and mathematicians. It appears that everything in the universe is related, which makes the statement made in 1908 by Hermann Minkowski rather obvious: "*The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical. Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality.*"

In 1908, Minkowski and other scientists of that era were unaware that we are constantly bathed in broadband electromagnetic (EM) radiation from the cosmos. At that time space was considered some quiescent domain where nothing is happening. The 1940 publication of the Grote Reber paper titled, "Cosmic Noise", revealed the existence of EM radiation, other than light, coming from space.[1] Since then, radio astronomers have revealed that the universe is a complex *EM Energy Transfer Structure* (EM-ETS), although they do not describe it as such. Space, whatever its composition, is an EM pathway, which justifies it being dimensioned using EM characteristics. Scientists in 1908 would never have considered defining spacetime using terms related to the EM phenomena and this seems to have been carried forward to today.

"A *kind of union of spacetime*" has already been mathematically defined by contemporary science using algebra and a measured value for the speed of light (SOL) using locally defined units of measure. Algebraically, the relationship can be expressed in three forms, equation set (1), where **c** represents the SOL, which is the constant of proportionality between wavelength, **λ**, and frequency, **f**.

$$c = \lambda f \quad (1a) \qquad \lambda = c/f \quad (1b) \qquad f = c/\lambda \quad (1c) \qquad (1)$$

Knowing any two values allows the third value to be calculated. The actual calculated numeric value will depend upon the dimensional descriptor that is used to express the value of each symbol, and the sizes of these have to be defined ahead of time. In the International System of Units (SI), the dimensional descriptor for **c** is meters per second (m^{-s}), **λ** is dimensioned using meters (m) and **f** is dimensioned using hertz (Hz). Hz is how many wavelength units that occur in one second. The size of the meter was established in 1799 before scientists were even aware of the existence of EM waves.

Whether a dimension in space is called a linear *unit of space* or a *wavelength* doesn't matter using the eq.(1) set or the geometric pair process that is described in the next sections. Frequency (**f**) in equation set (1) is the number of *wavelengths* or *units of space* (**n**) that occur in a *time unit duration* (**t**) which is expressed mathematically as f=n/t; when n=1 frequency is time inverted.

Electrical engineers have long used 2π to represent a generic wavelength, any frequency. Using the numeric value represented by 2π as one of the base dimensions of one triangle and a unit length of one (1) in a second identically shaped triangle establishes, in a geometric form, the inverse relationship between wavelength and frequency.

III. Euclidean Geometric Process and Spacetime

An isosceles right triangle is a special geometric form. Its elements can be expressed using any number of dimensional descriptors as long as every element of an individual triangle has the same descriptor. One of the simplest dimensions for a geometric element is a length, which could be the length of a unit of space. Similarly, the dimensions of an isosceles right triangle could be expressed as frequency, but there is little logical reason for doing so. There is no reason why two isosceles right triangles cannot be used, if properly linked, to express the relationship between two different types of dimensions, such as wavelength and frequency. This is already done using algebra, but algebra requires that the sizes of the dimensions be previously defined, such as the meter and the second.

The paired geometric process used to define spacetime does not require that you know the size of the units of measure ahead of time. The process involves mathematical and EM concepts that we already know. However, it took a period of time before we had all the necessary mathematical tools and related scientific knowledge to understand the meaning of the dimensions revealed by the isosceles right triangle pair.

a. First we need to know the mathematics of Euclidean geometry and algebra; both have been around for a few thousand years.

b. We require a reasonable familiarity with the union of electricity and magnetism, which began just under two centuries ago in 1820 when Oersted observed the deflection of a compass needle by an electric current. Maxwell's 1873 "Treatise on Electricity and Magnetism" provided a mathematical basis for electromagnetic waves. In 1888 Hertz definitively demonstrated that EM fields could be propagated through the air.

c. We need to know a reasonably accurate value for the SOL using some contemporary units of measure. The SOL was first measured in 1676 and improved measurement techniques and measurement instruments have improved on the accuracy until it is now within ±1 m^{-s}, as measured in a vacuum on the Earths' surface. Various units of measure have been used to express the numeric value for the SOL over the centuries. For the geometric process described herein, it makes no difference what units of measure are used to express the SOL.

d. We have to recognize that space is an EM pathway in the universe.

e. We have to know that a specific EM frequency exists that is linked to a specific atom; this was identified in 1951.[2] We have to know this frequency exists, and its source, because it is revealed as a product of specific numeric values created by the basic triangle pair process. Knowing that specific frequency exists allows us to identify a truly universal set of base units of measure.

II. Spacetime (Wavelength Frequency) Triangle Pair

The triangle pair concept presented herein is from a paper published in the July/August 2011 IEEE Potentials titled, "*A methodology to define physical constants using mathematical constants*."[3] The title accurately describes that mathematical constants can be used to define physical constants, as well as identifying a set of basic units of measure that are truly universal. This paper essentially describes how space and time are inextricably linked using the paired triangle process, but it would have been inappropriate to digress to that subject in ref. (3).

Linked isosceles right triangles, Fig. 1, are a fundamental requirement of the process. A mutual leg of each triangle has to be held as a constant; the vertical leg was chosen to be the link. This assures that a change in the angle (θ) opposite the linked legs preserves the relative relationships in both triangles.

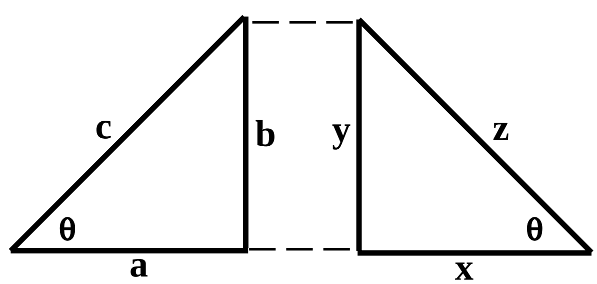

Figure 1. Linked Isosceles Right Triangles

Fig. 2 is the spacetime triangle pair with numeric values applied to the legs and the resulting hypotenuse value. A wavelength is the linear length of a wave, which could be any sized wave. The value 1 was selected as the generic value of a unit wavelength, which is equivalent to 1 unit length of space. Wavelength and frequency are inversely proportional, which is why using the numeric value of 2π as frequency for the dimension of that triangle preserves the inverse relationship between wavelength (space) and frequency (time inverted). Using the numeric value of 6.2831..., represented by 2π, as a base unit of frequency was a fortuitous selection.

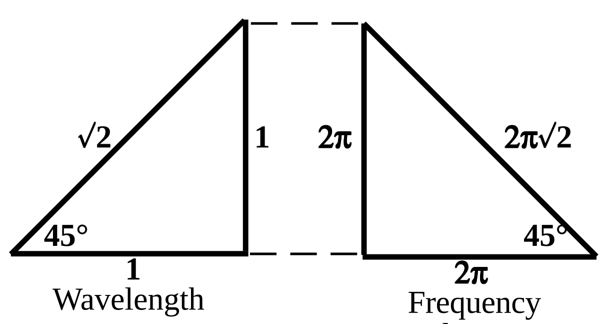

Figure 2 - Spacetime Triangle Pair

At this point in the process the actual physical size of the *wavelength* or *unit of space* is not known, nor the duration of the *unit of time*. These units are specified as *intrinsic units* in ref. (3). Unlike in eq. set (1), the value of **c** is not an elemental parameter of either of the paired triangles individually, it is mathematically defined by the product of specific dimensions of each triangle. When the basic numeric values for both legs of the two triangles are chosen correctly, the products of the vertical leg of one triangle times the hypotenuse of the other triangle will be equal; this is equivalent to the computation of eq. (1a).

The resulting numeric value, 8.885765876..., does not match what contemporary scientists have measured for the value of **c** using SI units. We know that **c** is the constant of proportionality between wavelength and frequency, which reveals that all three of the values used in eq. (1) set are present in the triangle pair process.

In my early science education, 1940s, I was taught that the SOL was 186,000 miles per sec. The numeric value is the result of the size of the *unit of length*, the mile; the second had the same duration as the SI second. Having different numeric values for the SOL was normal in my early science education and one would *translate* between different length dimensional descriptors as needed, which is no different than astronomers expressing distance in astronomical units (AU's) or light years. A variantion of the translation process was used to determine the sizes of the *spacetime units* relative to contemporary SI units.

III. Dimensioning Process

In the paired triangle process, the dimensional descriptor of the product of the fixed leg and the hypotenuse of the other triangle is length per unit time, which can be interpreted as frequency or velocity. There is no reason why a particular EM frequency and the velocity of an EM wave cannot have the same numeric value. The paired geometric process identifies the numeric value where the SOL and frequency are the same.

When expressing frequency using *intrinsic units,* ref. (3), frequency was dimensioned in length/time ($L\tau^{-1}$) using L as the length and tau (τ) as the time unit dimension. The duration of the time unit tau was not known until after the double iteration.

In the geometric process, the physical sizes of the fixed leg dimensions have to remain fixed relative to each other, but the angle can be varied. It was deduced that the angle opposite the fixed legs could be used to represent the time duration. The time duration unit was assigned a value of 1 at 45°, because at that angle, the cosecant value in this case, is midway between larger or smaller values when the angle changes. A double iteration process was used to vary the angle and calculate the value of **c** as the angle changed, producing the Fig. 3 results.

The starting point of the iteration was selecting the physical size of the fixed wavelength unit as 1 meter. The angle was progressively changed to determine what time unit angle and what metric value would result in the known SOL value in SI units. The calculations were carried out with a few more decimal places than shown in Fig. 3. The product of the vertical leg of one triangle times the hypotenuse of the other triangle matches the SOL in SI units at one particular angle, approximately 26.25400°.

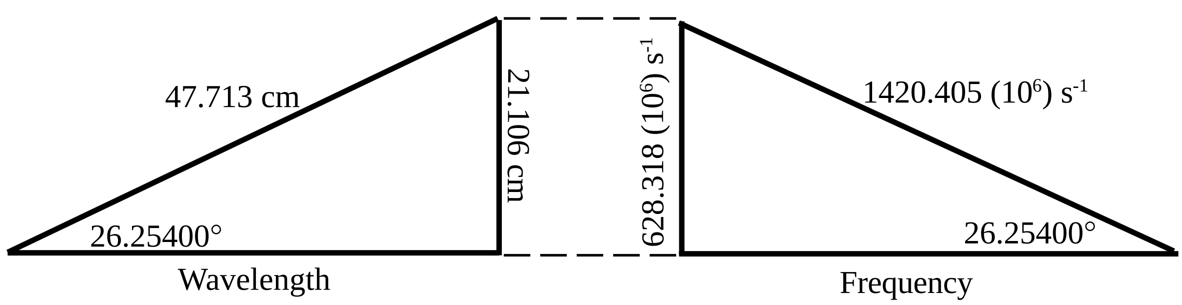

Figure 3. Spacetime SI Units

The EM spectrum position of the frequency with a numeric value of 1420.405 (10^6) Hz is at the same position spectrum position as that having a numeric value of 888.576 (10^6) $L\tau^{-1}$. The SI second is approximately 1.5985 longer than the *intrinsic time unit* duration.

The scaling was changed to 10^6 during the iteration process to accommodate the contemporary human viewpoint in regards to frequency. The resulting value of 21.106 cm represents the linear dimension of one unit of space expressed in an SI unit of measure when the angle represents the duration of the SI second.

Intrinsic units could be referred to as *Euclidean natural units* (ENU).

IV. Unit of Energy

With an EM source with constant output, Max Planck determined that the energy level of an EM wave is proportional to frequency, $E \propto f$. However, when new measurement instruments became available, it has been necessary to adjust Plancks constant and certain related SI units.[4]

Ref. (3) did not expand upon how to specifically establish a unit of energy except that it would be related to the *intrinsic frequency* identified by the triangle pair process, where the SOL and its related frequency have the same value. SI units can not identify the frequency where the SOL and its frequency are the same.

Using *intrinsic units*, the numeric value of energy, *E*, can be expressed as the ratio between a measured frequency, f_M, relative to the *intrinsic frequency*, f_I, eq. (2).

$$E = (f_M : f_I) \qquad \text{where } f_M > \text{or} < f_I \tag{2}$$

Intrinsic frequency is the value 888.576... $(10^6)\ Lt^{-1}$. It should be determinable, if measurement conditions are consistent, if there is just one natural source where E would be equal to 1.

V. Summation

Space and time are inextricably linked.

The IEEE Potentials editor requested the addition of a *Benefits* section to the ref.(3) report. The primary benefits identified in that section are the ability to create a set of basic scientific units of measure that are truly universal, establishing a basic unit of energy and producing time duration measurement instruments that are limited in significant figures only by our contemporary technical and computational capability.

References

[1] Reber, G., National Radio Astronomy Observatory, “Grote Reber and his Radio Telescope”, www.nrao.edu/whatisra/hist_reber.shtml

[2] H.I.Ewen, E.M. Purcell, “Radiation from galactic hydrogen at 1420 Mc../sec, Nature, vol 168, p,.356, 1951

[3] Makinson, F. H., “Methodology to Define Physical Constants Using Mathematical Constants”, IEEE Potentials July/August 2011, Vol. 30 Issue 4, pgs 39-43, 10.1109/POT.2011.940377 Postprint vip.ocsnet.net/~ancient

[4] Steiner, R. “History and progress on accurate measurements of the Planck constant,” 2013 Rep. Prog. Phys. 76 016101 doi:10.1088/0034-4885/76/1/016101 Available: http://iopscience.iop.org/0034-4885/76/1/016101/pdf/0034-4885_76_1_016101.pdf