

The Geometric Core of Spacetime

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Abstract—The mathematical abstraction of geometry has a good fit to physical law. A pair of very basic geometric forms can be linked to mutually define the size of the most basic units of measure, a unit length and a unit time duration and produce 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. The result of the paired geometric process identifies the perfect union between space and time.

I. Introduction

Sir Arthur Eddington stated that knowledge is innate: “*My conclusion is that not only the laws but the constants of nature can be deduced from epistemological considerations, so that we can have a priori knowledge of them.*” I do not believe there is a mysterious connection between physics and mathematics; it is a matter of identifying the most basic elements of a physical law and applying the proper mathematics. You cannot begin to discuss the characteristics of physical law without having identified the units of measure that apply. Ideally, the units of measure applicable to a basic physical law should be determined mutually. One should not equate defining units of measure in *terms* of physical constants as being the same as being mutually defined mathematically by the dimensional characteristics of a physical law.

One way to convince individuals that there is a connection between physics and mathematics is to illustrate the connection with a mathematical form that can be understood by everyone; basic geometry. Geometry is a methodology used to identify relationships between the various elements of a geometric form; however, it is not taught that these relationships can be applied to identify physical law characteristics mathematically in a way that cannot be done by measurement.

An isosceles right triangle is a special geometric form, and singularly, its elements can be expressed using any number of dimensions as long as every element of an individual triangle has the same dimensional descriptor. One of the simplest dimensions for a geometric element is a length. There is no reason why this unit length cannot be the length of a unit of space. Similarly, the dimensions of an isosceles right triangle could be expressed as frequency, but there appears to be 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 space and time. This is already done using algebra, but algebra requires that the sizes of the dimensions be predefined, such as the meter and the second.

Time is not something we can ignore, nor space, which has a dimension in all directions. 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 by Hermann Minkowski in 1908 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. Space was considered some quiescent domain where nothing is happening. The 1940 publication of the paper by Grote Reber titled, “Cosmic Noise”, revealed the existence of EM radiation 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, a measured value for the SOL and locally defined units of measure. The inverse physical law relationship between a wavelength and its frequency also applies to EM waves. Algebraically, the relationship can be expressed in three forms, equation set (1), where c represents the speed of light, which is the constant of proportionality between λ , the wavelength and f , the frequency.

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

Knowing any two values allows the third value to be calculated. The actual calculated numeric value will depend upon the dimensional descriptor that is desired 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 meters (m) and f is hertz (Hz). Hz is how many wavelength units that occur in one second, thus, it is not usable when a different time unit duration than the second is used.

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) and is expressed mathematically as $f=n/t$; when $n=1$ frequency is time inverted.

III. Euclidean Geometric Process and Spacetime

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 method 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 the phenomena. 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 $\pm 1 m^s$, as measured in a vacuum on the Earth's surface. Over the centuries, various units of measure have been used. For the geometric process described herein, it makes no difference what units of measure are used to express the SOL.

d. We have to know 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, and 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 paired triangle process.

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, but it would have been inappropriate to state that directly 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.

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

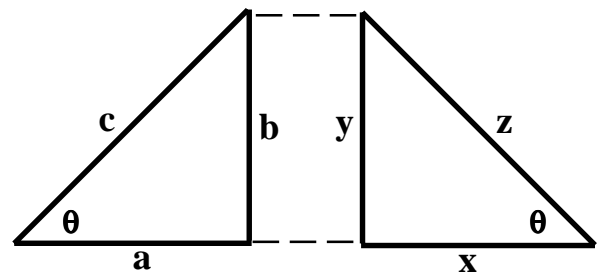


Figure 1. Linked Isosceles Right Triangles

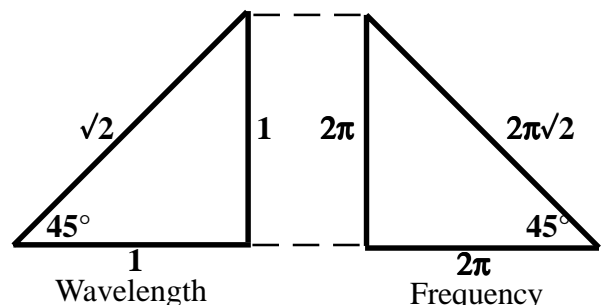


Figure 2 - Spacetime Triangle Pair

wave. The value 1 was selected as the generic value of a unit wavelength, which is equivalent to 1 unit of space. Electrical engineers use the numeric value of 2π to represent a generic unit of frequency for any size wavelength. Wavelength and frequency are inversely proportional, which is why using frequency as the dimension of that triangle preserves the inverse relationship between wavelength (space) and frequency (time inverted).

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 variant 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 an EM frequency and the velocity of an EM wave cannot have the same numeric value. 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.

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, which produced the fig. 3 results.

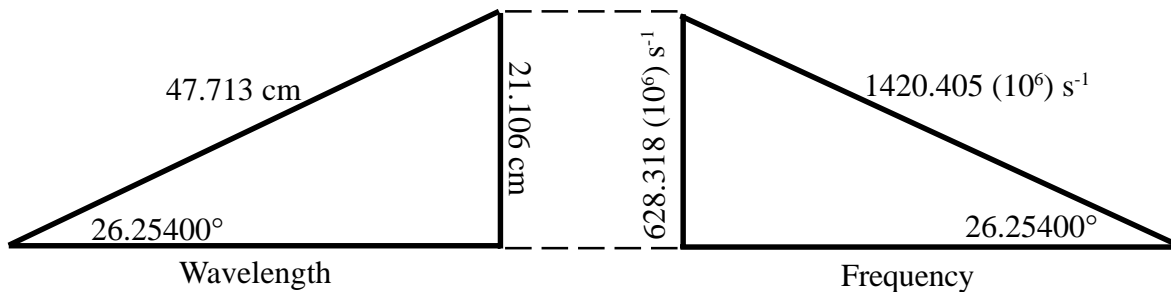


Figure 3. Spacetime SI Units

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.

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° .

The EM spectrum position of the frequency with a numeric value of 1420.405 (10^6) Hz is at the same 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.

IV. Summation

The paired isosceles right triangles allows two separate dimensions to be linked by a third, the third in this case the duration of a unit of time, which is represented by the angle opposite the linked legs.

The paired geometric process has a natural affinity to a specific physical law.

Space and time are inextricably linked

A mix of integers and transcendental numbers can be used to describe physical law values.

The term *Euclidean natural units* can be substituted for *intrinsic units*.

References

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