Exploring the Physicality of Physical Units in a One-Dimensional Universe

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Abstract

The dimensionality of the physical units as seen by an observer only capable of observations along the momentum axis is investigated. The units fall into seven groups characterized in terms of their 'frame signature', mainly interpreted as non-locality and/or impact. For example, momentum, power, resistance, magnetic charge, and electric potential are related and have a direct impact on the local observer. In contrast, time, charge, and mass are distributed and non-local. Energy squared is equivalent in frame signature of three local dimensions and may be factorized out to indicate which units may be seen in a 3-dimensional material world by the local quantum observer. In conclusion, the local quantum observer who is engaged in a measuring process over an interval of time has a more stringent and profound conceptual basis of the physical units than a classical observer interpreting distant processes occurring on a time axis.

INTRODUCTION

In 19:th and most of 20:th century physics the observer is located outside of the measured system and capable of measuring it not just once but twice or several times such as to be able to make an interpretation about a system process occurring on a time axis. Making the observer part of the measured system is an invention of quantum physics in the early 20:th century. The "working" quantum observer incessantly interacts with the measured object and each time an observation is made the whole system comprising object and observer changes. The classical quantum observations occur in one dimension along the momentum axis. Quantum observations made by a working and interacting observer are confined to the local measuring device. In contrast, classical physics disregards the measuring process and arrives at conclusions about faraway objects disengaged from the local and the real. This leads in the extension to the well known world picture in which the whole universe is regarded as an expanding fireball possible to comprehend by taking an external observer's position. Therefore, the observer in classical physics is truly a "divine" observer (Fig. 1).

The working observer in quantum physics on the other hand is more concerned with local processes occurring along the chosen axis of observation in one dimension only. His roots are in measuring the radiation from atoms, especially from the hydrogen atom. The observer of the hydrogen atom sees radial quantum jumps and momentum transfers along the axis of observation whereas the object exhibits a tangential velocity, that of the orbiting electron. The movement of the electron perpendicular to the axis of observation can not be seen less its orbit is perturbed.

The working quantum observer may also lift his eyes towards the cosmological horizon to try and apply his simple reference geometry on a larger scale. He will not be inclined to sweep under the carpet the finding that there is no empirical evidence of any literal cosmological expansion (1) since the radial line increment is inherent in his reference geometry. Like the divine observer he is able to calculate numerical values of the radius of the visible universe, its age, density, and the density of the cosmological background radiation. Whereas the divine observer relies on distant observations in doing so, the working quantum observer derives all numerical data from the local geometry of the hydrogen atom, the commonest and most primordial element of the universe. Notwithstanding the completely different source of the data the numerical agreement between the two perspectives may reach the third digit (2,3). The quantum observer further compensates his narrow perspective by estimating resonances between elementary particles and the apparent expansion rate, concluding that neutrons and protons are stable because their masses are shifted by $\pi/2$ off resonance (3,4).

However, the mere fact that the quantum observer can construct a world picture based upon his simple one-dimensional geometry does not automatically grant access to a wider range of empirical physics. Many physical laws are strongly anchored in a three-dimensional world or even a four-dimensional one having a time axis. The right question to ask is therefore: "How would the working quantum observer see the physics that his divine colleague already has described?" The purpose of this text is to aim at an answer by starting to examine the physical units. A key to interpreting how the quantum observer sees the physical units has been to reject a time axis in favor of a time interval enclosing the state of the system before and after the observation. Since there is no time axis in the observer's frame the unit of time is assigned to a yonder (read 'space-like separated') frame perpendicular to the axis of observation.

RESULTS

The simple rules and notations used in defining the frame assignments (subsequently herein called 'frame signature' or 'signature') of the physical units have been described previously (6). Briefly, a tilde over a symbol denotes the yonder, space-like separated frame while a bar over a symbol denotes the local laboratory frame. These are connected by the condition $\widetilde{a}\widetilde{a} = \overline{a^2}$ In principle, the frame signature on both sides of an applicable equation should cancel just like the numerical values, the physical units and any vector or scalar properties cancel classically.

The dimensionless fine structure constant α provides the easiest way of identifying how the electromagnetic entities are made up of contributions from axes parallel ($^{-}$) and perpendicular ($^{\sim}$) to the direction of observation. Since the frame signature, D( ), of charge is $D(e) = ^{\sim}$, of charge squared $D(e^2) = ^{-}$, of $D(\hbar) = ^{=}$, and of the velocity of light, $[c] = [m/s] = ^{-}/^{\sim}$ (cf. 4), the frame signature of permittivity, ϵ_0, and permeability, μ_0, of vacuum can easily be found:

$$D(\alpha) = D(\frac{e^2}{h\ c\ 2\ \epsilon_0}) = 0 \Rightarrow \frac{^{-}}{(^{=})\ (^{-}/^{\sim})\ D(\epsilon_0)} \Rightarrow D(\epsilon_0) = ^{\sim}/\ ^{=} \tag{1}$$

$$D(\alpha) = D(\frac{\mu_0\ c\ e^2}{2\ h}) = 0 \Rightarrow D(\mu_0) = ^{\sim}\quad : \tag{2}$$

The permittivity has the signature of energy density and the permeability that of time. By reference to c;

$$D(\epsilon_0\ \mu_0) = \frac{\sim\sim}{--} = 1/- \Rightarrow \tag{3}$$

$$D(\sqrt{\epsilon_0\ \mu_0}) = 1/^{\sim} = ^{\sim}/^{\sim\ \sim} = ^{\sim}/^{-} = D(1/c)\quad , \tag{4}$$

as expected. Since for energy, U, and force, F, $D(U) = ^{=}/^{\sim} \Rightarrow D(Force) = ^{-}/^{\sim} = ^{\sim}$, the electric field $E = F/q$, where q is charge has frame signature zero,

$$D(E) = ^{-}/^{\sim\ \sim} = ^{-}/^{-} = 0\quad , \tag{5}$$

which may be checked in the expression for the field surrounding a point charge using Eq. 1:

$$E = \frac{1}{4\pi\epsilon_0}\ \frac{e}{r^2} \tag{6}$$

where 4π is a dimensionless constant.

The Lorentz-invariance of $E^2 - c^2\ B^2 = E^2 - c^2\ B'^2$ implies

$$D(B) = ^{\sim}/^{-} \tag{7}$$

whereas the signature of magnetic charge may be deduced from i.a.

$$D(\frac{ce}{2\alpha}) = ^{-}\quad . \tag{8}$$

Based on these results, the physical units may be sorted together with other relevant entities into seven groups as shown in Table I. It is evident that the units appearing in the same group are related conceptually.

Namely, the units in Group A are characterized by being *referenced*: They are not detectable unless the measured object interacts physically with another object displaying the same property. Thus, the detection of a time axis relies on a clock, electric charge requires another charge to be defined and the detection of mass and force depends on a reference mass respectively a counter-force. Secondly, the units in Group A apply to *spatially distributed* objects. For example, time measures the evolution of complex systems comprising more than one object or constituted by many elements. Mass and charge are distributed throughout the universe. Likewise, the wave-front to which the constant c applies becomes weaker and more widely distributed at longer radii and so does the force.

In contrast, measurements of the units in Group B apply directly to the *local* observer, comprising length along the chosen axis of observation, momentum transfer, power, resistance, and electric potential. By inference, magnetic charge refers only to the quantum observer. All these units may be said to have an *impact* on the local observer, consistent with the classical meanings of these units. The impact dimension need not be scalable beyond the local observer, which distinguishes it from a classical spatial dimension.

The units in Group C, energy and magnetic flux, have a signature that may be assigned to thrice a virtual (yonder or space-like separated) dimension. Since the local observer can not see these dimensions they may be regarded as perpendicular (cf. 6). Their mutual orientations need not *a priori* be perpendicular, however, which complicates the local observer's perception of physics described by 3-dimensional vector calculus. By factorizing out the squared frame signature of energy and taking the cubic root of the residue these units may be assigned to three local spatial (and perpendicular) dimensions divided by a virtual dimension. Hence, the units in Group C are related to a 3-dimensional world possibly having a time axis. Their signature is the same as that of the gravitational constant, G.

Next, in Group D), the energy density (per *local* volume element), electric flux density and pressure are scalars divided by thrice a virtual dimension, indicating they are not connected to the one-dimensional universe seen by the quantum observer. These scalars are distributed along three virtual dimensions from the viewpoint of the local observer at the momentum axis. Like the units of Group C and G (see below) they are solvable in a three-dimensional world by factorizing out the squared signature of energy and taking the cubic root of the residue, yielding a momentum dimension times thrice a virtual dimension

In Group E, the units frequency, magnetic flux density, magnetic charge density, and magnetic field strength, are seen as scalars divided by a virtual dimension. They may therefore appear to the quantum-observer to be distributed perpendicular to the axis of observation and (in contrast to magnetic charge) not accessible for direct observation.

The units in Group F, comprising magnetic field (H), intensity, electric charge density with the Poynting vector are seen as scalars distributed over one local dimension. Alternatively, they are seen as being non-local and distributed over three non-local dimensions. Factorizing out three local dimensions (energy squared) to make these units compatible with a 3-dimensional world leaves a residue of four local dimensions, which is solvable in a 2-dimensional world. These units may therefore be regarded as mapping 3 into 2 dimensions, as seen by the quantum observer.

The units in Group G, comprising acceleration, current, energy density (per *non-local* volume element) and electric field strength, are scalars, reflecting that a line and a time increment are inherent in the geometry, which stretches while being measured. Hence, gravitational and centrifugal acceleration are indistinguishable (concealed in the coordinate system) from the point of view of the quantum observer. Vacuum fluctuations and the (displacement) current may be regarded as inherent in the geometry as well.

Most, but not all, physics seems to naturally accommodate this new and unusual perspective taken by assigning a frame signature to the physical units. Some expressions may seem ambivalent. For example, the choice between local and non-local volume for the densities is context-dependent. Particularly physics based on vector calculus in $> 2D$ is not self-evident. An example is provided by Maxwell's equations:

ME I, with charge density ρ, of dimension $D(\rho) = \tilde{}/\ \tilde{}\ \tilde{}\ \tilde{}$ ($\tilde{}$ preferred over three local dimensions, $\bar{}$, for consistency and based on the argument that a quantity confined to the yonder frame distributes over that frame) yields

$$\nabla \cdot E = \frac{1}{\epsilon_0}\rho \Rightarrow D(\nabla \cdot E) = \tilde{} \Rightarrow D(\nabla \cdot) = \tilde{} \tag{9}$$

Since $(\nabla \cdot) = 1/\bar{}$, ME IV is consistent with the above;

$$\nabla \cdot B = 0 \Rightarrow D(\nabla \cdot B) = \tilde{}\ \tilde{}/\ \_ = 0 \tag{10}$$

ME II,

$$\nabla \times E = -\frac{\partial B}{\partial t} \Rightarrow D(\nabla \times E) = 1/\acute{}\ \ . \tag{11}$$

yields

$$D(\nabla \times) = 1/\bar{} \tag{12}$$

which cancels in ME III

$$\nabla \times B = \mu_0 (j + \epsilon_0 \frac{\partial E}{\partial t}) \ \ , \tag{13}$$

only provided the displacement current has signature $1/\ \_\ \_$.

These tentative adaptations of vector calculus to the perspective of an observer looking in one dimension only should be regarded as context-dependent and knot that general.

Table I

(Comp)	Basic	Unit	Alternative	3D	t^{-1}	t^{-1} (Comp)
¯	∼	Group A:	¯/ ∼	∼/ ¯ ¯ ¯	1	∼
		Time (sec)		N.A.		
		Mass (kg, sec)				
		Electric Charge (C)				
		Electric Flux				
		Force (N)				
		c				
		Vector Potential, A				
∼∼∼	¯	Group B:	∼∼∼/ ∼	1/ ¯ ¯	¯/ ∼	¯
		Length (m)		N.A.		
		Momentum				
		Power (W)				
		Resistance (Ω)				
		Magnetic Charge $\overline{C}$				
		Electric Potential (V)				
¯ ¯	∼∼∼	Group C:	¯ ¯/ ∼	Y/ ∼	¯	∼∼∼
		Energy (J)				
		Magnetic Flux (Wb)				
		$G = c^3$				
1/_	1/ ∼∼∼	Group D:	∼/_ _	Y ∼∼∼	1/_ _	1/ ∼∼∼
		Energy Density (Vol ¯)				
		Electric Flux Density (C/m^2)				
		Pressure (Pa)				
		Electric Displacement				
1	1/ ∼	Group E:	∼/ _	∼/ _ _ _ _	1/ _	1/ ∼
		Frequency (Hz)		N.A.		
		Magnetic Flux Density (T)				
		Magnetic Charge Density (Vol ∼)				
		Magnetic Field Strength, B (T)				
1/ ∼	1/ _	Group F:	∼/ ∼ ∼ ∼	1/ _ _ _ _	∼/ _ _	1/ _
		Magnetic Field, H (A/m)		N.A.		
		Intensity (VA/m^2)				
		Electric Charge Density (Vol ∼)				
		Poynting Vector (W/m^2)				
_/ ∼	1	Group G:	¯/ ∼∼	Y/ _	1/ ∼	1
		Acceleration				
		Current (A)				
		Energy Density (Vol ∼)				
		Electric Field Strength (V/m)				
		Material Constants:				
¯	∼	Permeability H/m	¯/ ∼	∼/ _ _ _	1	∼
1/_	1/ ∼∼∼	Permittivity, F/m	∼/_ _	Y ∼∼∼	1/_ _	1/ ∼∼∼
1	1/ ∼	Capacitance (F)	∼/ _	∼/ _ _ _ _	1/ _	1/ ∼
1/ ∼	1/ _	Conductance	∼/ ∼ ∼ ∼	1/ _ _ _ _	∼/_ _	1/ _
¯ ¯	∼∼∼	Inductance (H)	¯ ¯/ ∼	Y/ ∼	¯	∼∼∼

This Table might become available improved at
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Text to Table I. Related physical units and entities grouped according to their 'frame signature' as seen in a one-dimensional universe by a local (barred) observer capable of direct observations along the axis of observation (= momentum axis) and indirect measurements perpendicular to this axis (indicated by a tilde). The names of the physical units and notations in parenthesis in the 'Systeme International' appear in the third column ('sec' is used for 's') with two alternative (and equivalent) frame signatures immediately to the left and right. Densities based on local and non-local volumes (Vol) are indicated by bars and tildes respectively. The signature to the far left (first column, 'comp' for 'comparison') is derived by multiplying the basic one by that inherent in the geometry, $^{-}/\,\sim$. The signature in the column marked '3D' is obtained by factorizing out the squared frame signature of energy and taking the cubic root of the residue unless this is not possible. The signature of the squared energy is thrice a local dimension (3D) denoted by the letter 'Y'. In incompatible cases the signature of the residue appears and the first physical unit in the group is marked 'N.A.'. In the sixth column the basic frame signatures are divided by that of time in order to get the dimension of an entity undergoing quantitative changes with time and in the seventh column those time derivatives are compensated for the dimensionality inherent in the geometry as indicated above. The special names of the physical units and their SI base units may be found in Ref. 7, some have been taken from Ref 8.

REFERENCES

1. R. Lieu and D. A. Gregory, *The exclusion of WMAP's Hubble constant by laser interferometry.* arXiv:astro-ph/0605611 v1, May 24, 2006.

2. E. A. Cerven, *Calculation of Cosmological Observables from Constants of Nature.* http://www.scienceandresearchdevelopmentinstitute.com/cosmoa.html (2003, 2005)

3. E. A. Cerven, *Calculation of Cosmological Observables from Constants of Nature. In: Part II of e-book 'Reaching for the Universe'* http://www.scienceandresearchdevelopmentinstitute.com/cosmoa.html (2005)

4. E. A. Cerven, *Evidence of Resonance between the W-boson and the Apparent Cosmological Expansion Rate.* http://www.scienceandresearchdevelopmentinstitute.com/cosmoa.html (2005)

5. E. A. Cerven, *Attempts at Systematizing the Masses of the Elementary Particles - Focus on 3.6 GeV.* http://www.scienceandresearchdevelopmentinstitute.com/cosmoa.html (2006)

6. E. A. Cerven, *Geometry of the Universe and the Ground State of the Hydrogen Atom* http://www.scienceandresearchdevelopmentinstitute.com/cosmoa.html (2005)

7. A.M. Portis, *Electromagnetic Fields: Sources and Media.* John Wiley & Sons, New York, Chichester, Brisbane, Toronto, Singapore, 1978.

8. A. Rohrbach and E. H. K. Stelzer, *Optical trapping of dielectric particles in arbitrary fields* J. Opt. Soc. Am. A 18(4), 839-853 (2001)

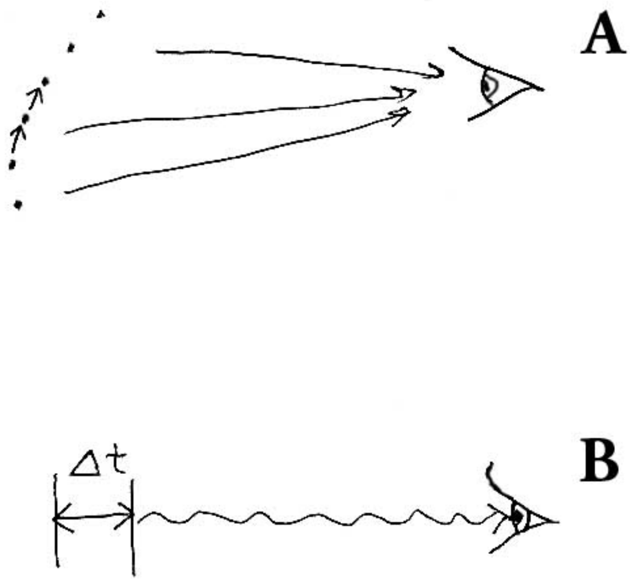

Figure 1: Comparison of the roles of a classical observer in physics, A, and a quantum observer, B. The former contemplates the information coming from the studied object at a distance while the latter processes the real signals when they arrive.