Discussion on Satz Derivation of Planck's Constant

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(1) The ability to move away from established patterns of thinking and strike a new avenue of approach is a rare characteristic but most desirable for research. In his paper, "A New Derivation of Planck's Constant,"[1] Satz comes up with such a fresh approach. He suggests that "frequency in the natural sense is the number of cycles per space-time unit." This is at variance with Larson's view that "…the so-called 'frequency' is actually a speed. It can be expressed as a frequency only because the space that is involved is always a unit magnitude."[2] I am not in the least maintaining that concurrence with Larson's views is the criterion of truth. But in this instance, the recognition that frequency is really speed seems nearer the truth, since in the context of the theory of the universe of motion, the criterion that decides the truth of a concept is whether it is explainable in terms of the basic component of that universe, namely, speed.

Satz supports his conclusion by the statement: "Photons of all frequencies can be observed in both sectors, and the only way that this could be possible is if the denominator of the natural definition contains both a space unit and a time unit." In order to see the falsity of this statement it is necessary to remember that a photon has two speeds: the speed of propagation in the forward direction, and the speed of oscillation in the lateral direction. The fact that the speed of propagation is of constant magnitude and unit value (in the natural units) is what makes the photon observable in both sectors, since unit speed is the boundary between these sectors. The frequency, which is the speed in the lateral direction and which is the measure of its energy, is not relevant to its observability from both the sectors.

(2) Satz gives in space-time terms the equation

$$E = h\nu \qquad (1)$$

as

$$\frac{t}{s} = \left[\frac{t^2}{\left(\dfrac{t/s}{t/s} \right)} \right] \frac{1}{s \times t} \qquad (2)$$

and in the cgs system of units

$$erg = \left[\frac{sec^2}{\left(\dfrac{sec/cm}{erg} \right)} \right] \frac{1}{cm \times sec} \qquad (3)$$

It is to be noted that in this, the dimensions of frequency are taken to be cycles/(*cm*-*sec*). On this basis only he continues and arrives at the value of *h* in Equation (5). At this juncture *h* has the dimensions *erg*-*sec*-*cm* and frequency *cycles*/(*cm*-*sec*). He now adopts the following procedure: he detaches the *cm* dimension from the frequency and attaches it to *h*, rendering its dimensions *erg*-*sec*. Let us call this

1 Satz, Ronald W., "A New Derivation of Planck's Constant," *Reciprocity* XVIII, № 3 (Autumn, 1989).
2 Larson, Dewey B., *Nothing But Motion*, North Pacific Publishers, OR, 1979, p. 152.

procedure of his the "swap" for later reference. This procedure has the effect of insulating this *cm* term from the effects of any operations that are uniformly carried out on all the terms comprising *h*, because he "swaps" this *cm* term into *h* only after performing those operations on the terms comprising *h*.

(3) After incorporating the interregional factor into the terms contained in the square brackets of Equation (3) he arrives at the Planck's constant *h* as

$$\frac{1}{156.4444} \times \frac{t_0^2}{\left(\frac{cm/sec}{erg}\right)} \tag{4}$$

If one compares the terms comprising *h* respectively in Equation (3) and Equation (4), it becomes apparent that the author unwarrantedly introduces in Equation (4) the term t_0^2, replacing the term sec^2. I will call this procedure of his the "switch." All the terms in Equation (3) are in the cgs system of units. The rationale for making this "switch" is not given: only the numerator term is "switched," retaining the other terms in the cgs units. Further, if the "swap" is not carried out, the *cm* term we wish to avoid finally in the frequency would find place in *h* right from the beginning, making it

$$\frac{1}{156.4444} \times \frac{sec^2/cm}{\left(\frac{cm/sec}{erg}\right)} \tag{5}$$

As such, if he has reasons to "switch" the *sec* term in the numerator to the natural unit of time, the same reasons would compel the "switching" *cm* term also to the natural unit of space. This, of course, produces the wrong result. The "swap" serves to avoid just this.

(4) At two places Satz comments on my attempt[3] to calculate the Planck's constant. He contends that I "started by setting the dimensions of energy to be space divided by time, which is, of course, the reverse of what they are." If my Paper is read carefully it would be found that this is not what I did. I have clearly shown in my Equation (l) the relation between energy and speed in space-time terms as

$$\frac{t}{s} = \frac{t^2}{s^2} \times \frac{s}{t} \tag{6}$$

I explained that expressing all the quantities in the natural units we obtain from the above energy in natural units = $(1/1)^2$ speed (in natural units), since the term t^2/s^2 , the square of the natural unit of inverse speed, is unity. In other words, so far as primary units are concerned, *n* natural units of speed, say, are equivalent to *n* natural units of energy. I had even taken care to explicitly mention that the latter is a quantitative relationship. Despite this, Satz has misconstrued it as a dimensional relationship. I had, in addition, pointed out Larson's account (see Reference 2 of my Paper) for the sake of elucidation.

(5) The other place at which Satz contends that I was guilty of a dimensional mistake is in connection with my modification concerning the effect of secondary mass. While deriving the magnitude of the natural unit of energy, I think we should distinguish between the energy equivalents of the speed of a primary motion like the (one-dimensional) photon vibration and the speed of a gravitational entity (like an atom or subatom). This would not have mattered if we could derive the magnitude of the natural unit of energy directly from experimental results. But Larson first derives the magnitude of the natural unit of mass from Avogadro's constant. The magnitude of the natural unit of energy is derived from the natural unit of mass, thus derived. Therefore, the size of this energy unit is to be adjusted for the secondary mass effects as

3 KVK Nehru, "Theoretical Evaluation of Planck's Constant," *Reciprocity* XII, № 3 (Summer, 1983), p 6.

applicable to the one-dimensional situation.

Letting *p* be the primary mass and *s* the secondary mass, we have the ratio of the gravitational mass unit to the primary mass unit as $(p + s)/p$. Remembering that the dimensions of energy are t/s while those of mass are $(t/s)^3$, the ratio of the energy unit derived from the gravitational mass unit to the true one-dimensional energy unit would have to be $[(p + s)/p]^{1/3}$. Since the primary mass unit, $p = 1$, this factor turns out to be $(1 + s)^{1/3}$. It may be noted that this factor is non-dimensional, being a ratio, and its application (my Equation (7)) does not vitiate the dimensions of *h* as Satz contends.

Further, Satz remarks that, "secondary mass varies between the subatoms and the atoms and so cannot be a part of the conversion factor…" But this is not relevant to the situation, since I was concerned with the effect of the secondary mass included in the definition of the gravitational mass unit on the size of the natural unit of energy, insofar as the latter is derived from the unit of gravitational mass. I was not speaking of the secondary mass component included in the mass composition of the material particles at all, since that has no bearing on the present issue, as Satz correctly points out. I was, however, uncertain as to which items make up the secondary mass—like the magnetic mass, the electric mass, etc.—in the situation I was discussing.

(6) And a final comment: In Satz's Equation (4)

$$h=\frac{1}{156.4444}\times\frac{t_0^2}{\left(\frac{sec/cm}{erg}\right)} \tag{7}$$

replacing all the terms with the corresponding natural units we get

$$h=\frac{1}{156.4444}\times\frac{t_0^2}{\left(\frac{t_0/s_0}{e_0}\right)}=\frac{1}{156.4444}\times\left(e_0\times t_0\times s_0\right) \tag{8}$$

If we now bring in the *cm* term that has been staying in the denominator of the frequency term, we

$$h=\frac{\left(e_0\times t_0\times s_0\right)}{\left(156.4444\times 1\,cm\right)} \tag{9}$$

This is identical to my Equation (6) (seeing that I there used suffix *n* instead of suffix *0* and the upper case letters instead of the lower case) and, therefore, there is nothing essentially new in Satz's derivation excepting the introduction of the "swap" and the "switch."