Derivation of Photon Mass and Avogadro Constant from Planck units

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Originally proposed in 1899 by German physicist **Max Planck**, Planck units are also known as natural units because the origin of their definition comes only from properties of the fundamental physical theories and not from interchangeable experimental parameters. It is widely accepted that Planck units are the most fundamental units. In this paper, few more fundamental constants are derived from Planck units. These constants are permutations and combinations of Planck units and hence by construct, they are also constants. The mass and radius of photon are derived. The Avogadro constant, Boltzmann constant and unified mass unit are also derived. The structure of the photon is explained. The meaning of Avogadro constant in terms of photon structure is also explained. The meaning of Planck mass is explained. As proof for the meaning of the Planck mass, the solar constant is derived. The solar constant is derived applying string theory as well. Finally revised Planck current, Planck voltage and Planck impedance are also derived. It is also proven that Planck mass is the energy emitted by any star per second per ray of proper length c. Apart from this, the energy emitted per second per ray of proper length c by a planet or communication antenna is not equal to Planck mass.

I. INTRODUCTION

In physics, **Planck units** are physical units of measurement defined in terms of five universal physical constants.They are particularly relevant in research on unified theories such as *quantum gravity*. The universal constants that Planck units, by definition, normalize to 1 are:

- the gravitational constant,,G
- the reduced Planck constant,$\hbar$
- the speed of light in a vacuum,c
- the Coulomb constant,$(4\pi\epsilon_0)^{-1}$
- the Boltzmann constant,k

All systems of measurement feature base units: in the International System of Units (SI), for example, the base unit of length is the metre. In the system of Planck units, the Planck base unit of length is known simply as the Planck length, the base unit of time is the Planck time, and so on. These units are derived from the five dimensional universal physical constants and are tabulated in table I.

TABLE I Base Planck units

Name	Expression	Value (SI units)
Planck mass	$m_p = \sqrt{\frac{\hbar c}{G}}$	2.17651×10^{-8}
Planck length	$l_p = \sqrt{\frac{G\hbar}{c^3}}$	1.616199×10^{-34}
Planck time	$t_p = \sqrt{\frac{G\hbar}{c^5}}$	5.39106×10^{-44}
Planck charge	$q_p = \sqrt{4\pi\epsilon_0\hbar c}$	$1.8755459 \times 10^{-18}$
Planck temperature	$T_p = \sqrt{\frac{\hbar c^5}{Gk^2}}$	1.416833×10^{32}

In this paper, some fundamental constants are derived from Planck units. They are the mass and radius of the photon, Avogadro constant, Boltzmann constant and the unified mass unit. In section II the mass and radius of the photon and the Avogadro constant are derived. Along with them, the unified mass unit and the Boltzmann constant are also derived. In section III, the proof for section II is presented. In section IV,the solar constant is derived applying string theory. In section III, the proof is presented for what has been claimed in section II. In section III, the solar constant is derived (not measured) based on the arguments presented in section II. In section II, the structure of the photon is also discussed. This derived solar constant is closely matching with the observed solar constant. Solar constant is defined as the amount of power received per unit area at the distance of 1AU from sun. One astronomical unit is defined as the mean distance between the sun and earth in its orbit. In section V, revised Planck current (I_{pr}) and the revised Planck voltage (V_{pr}) are derived. From voltage and current, the revised Planck impedance (Z_{pr}) is also derived. It is proven that the impedance of free space varies with frequency.

II. DERIVATION OF PHOTON MASS AND AVOGADRO CONSTANT

Multiplying m_p and t_p the following equation is obtained.

$$m^p = m_p \times t_p = \sqrt{\frac{\hbar c}{G}}\sqrt{\frac{G\hbar}{c^5}} = \frac{\hbar}{c^2} = 1.17336915\times10^{-51} kg.s \quad (1)$$

In the above equation, the photon mass (2) (1) is denoted by m^p. Multiplying l_p and t_p the following equation is obtained.

$$r_p = l_p \times t_p = \sqrt{\frac{G\hbar}{c^3}}\sqrt{\frac{G\hbar}{c^5}} = \frac{G\hbar}{c^4} = 8.71193038\times10^{-79} m.s \quad (2)$$

Dividing Eq.(2) by Eq.(1) the following equation is obtained.

$$Q = \frac{G\hbar}{c^4} \div \frac{\hbar}{c^2} = \frac{G}{c^2} = 7.42471382 \times 10^{-28} m \quad (3)$$

If Planck mass, length and time are constants, then their permutation and combination derived in Eq.(1) to Eq.(3) are also constants. In the theory presented in this manuscript,$m_p = \sqrt{\hbar c/G}$, $m^p = \hbar/c^2$ and $Q = G/c^2$ are the fundamental units. Rest of the units are derived units.

A. Unified mass unit

The unified mass unit can be derived by multiplying Q by 2. This is done in the following equation.

$$u = Q \times 2 = \frac{2G}{c^2} = 1.48494276 \times 10^{-27} kg \quad (4)$$

B. Avogadro number

Avogadro number can be derived by dividing Q by m^p. This is done in the following equation.

$$N_A = \frac{Q}{m^q} = \frac{G}{c^2} \div \frac{\hbar}{c^2} = \frac{G}{\hbar} = 6.32768778 \times 10^{23} \quad (5)$$

C. Boltzmann constant

Boltzmann constant can be derived by dividing 10 by N_A. This is done in the following equation.

$$k = 10 \times \frac{1}{N_A} = \frac{10\hbar}{G} = 1.58035610 \times 10^{-23} JK^{-1} \quad (6)$$

If Eq.(1) to Eq.(3) are constants, then their permutation and combinations Eq.(4) to Eq.(6) are also constants. The constants derived in this section are listed in table II.

TABLE II Derived units from Planck units

name	expression	value
photon mass m^p	$\hbar/c^2$	$1.17336915 \times 10^{-51} kg$
photon radius r_p	$G\hbar/c^4$	$8.71193038 \times 10^{-79} m$
Q	G/c^2	$7.42471382 \times 10^{-28} C$
unified mass unit u	$2G/c^2$	$1.48494276 \times 10^{-27} kg$
Avogadro constant N_A	$G/\hbar$	$6.32768778 \times 10^{23}$
Boltzmann constant$k$	$10\hbar/G$	$1.58035610 \times 10^{-23} JK^{-1}$

D. The structure of photon and the importance of Avogadro constant

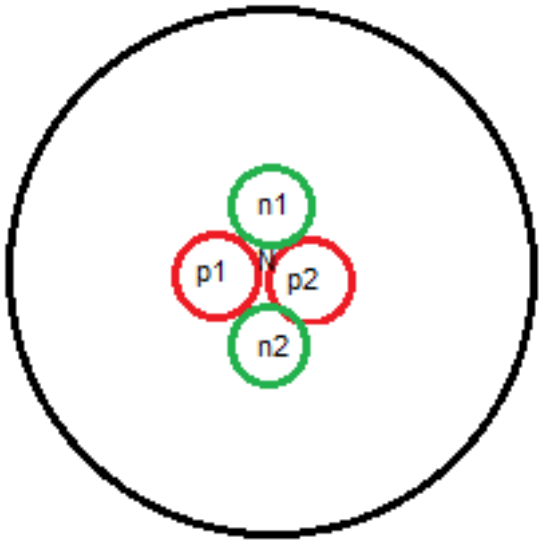

FIG. 1 The structure of the photon and Avogadro constant

The mass and the radius of the photon are derived in Eq.(1) and Eq.(2) respectively. The photon is a sphere of very minute radius. Nothing else about the photon is known at this moment. It is time to explore the structure of the photon. The structure of the photon is shown in Fig.(1). In Fig.(1) red color is positive spot on the surface of the sphere. Green color is negative spot on the surface of the photon sphere. The area denoted by N is the neutral spot on the surface of the photon sphere. Similar to this, there are N_A number of positive spots and N_A number of negative spots. The number of neutral spots is not known at this moment. **That is the importance of Avogadro number N_A. Thus Avogadro number arises naturally from the photon.** The natural logarithm constant e might have arosen from the neutral area of the photon sphere.

E. The meaning of Planck mass

The Planck mass is $m_p = \sqrt{\hbar c/G} = 2.17651 \times 10^{-8}$. In the theory presented in this paper, Planck mass is defined as the mass of one string of proper length c or one ray of proper length c. **The proof for this is presented in section III**. In section III, the solar constant is derived. Using the measured value of the solar constant, the derived constant is calibrated.

III. THE PROOF OF THE THEORY

Before beginning certain assumptions were made. G/c^2 is the mass of one wave packet whose frequency is integrated from 0 to f_{max} and this is universal. Universal means for any **star** the emitted wave packet's mass is G/c^2. One wave packet consists of frequency from 0 to f_{max}. This can be justified from the fact that G/c^2 is an universal constant as shown in section II, and also G/c^2 is very close to the unified mass unit.

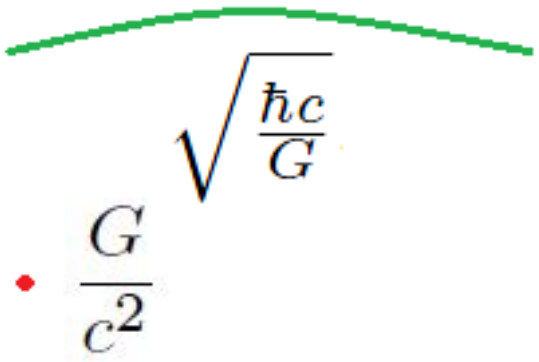

FIG. 2 One ray and one wave packet with their mass denoted

In Fig.(2), the red dot denotes the wave packet and it's mass is denoted as G/c^2. In the same figure the green flux tube whose proper length is c is also represented and it's mass is equal to $\sqrt{\hbar c/G}$. Now the stage is set to derive the solar constant. The solar luminosity is denoted by $L_\odot$ and is equal to 3.846×10^{26}. The mass radiated by sun per second is denoted by M_r and is equal to 3.64921×10^9 $(L_\odot/c^2)$. Let n denote the number of rays (flux tubes) emitted by the sun. As per this theory n is given by the following equation.

$$n = \frac{L_\odot}{m_p c^2} = 1.6767334 \times 10^{17} \tag{7}$$

4π steradian is shared by n rays. Let θ denote the solid angle subtended by one ray and it is given by the following equation.

$$\theta = \frac{4\pi}{n} = 7.49442112 \times 10^{-17} steradian \tag{8}$$

At a distance of $1AU(1.4959787066 \times 10^{11} m)$ the area occupied by a single ray is denoted by A and is given by the following equation.

$$A = \theta \times AU^2 = 1.67721569 \times 10^6 m^2 \tag{9}$$

Mass per ray is m_p and hence energy per ray of proper length c is denoted by E_p and is equal to 1.95614963×10^9. Since this energy is calculated per ray, it's unit can be taken in terms of watts. The solar constant is denoted by c_p and it is derived by the following equation.

$$c_p = \frac{E_p}{A} = 1166.2784 W/m^2 \tag{10}$$

But the measured value of solar constant is $1366 W/m^2$. Then why is this discrepancy? It is because in the calculation, the angle between flux tubes were not taken into account. So the angle actually occupied by a ray is 0.84635569(1166.2784/1366) times less than what is used in the calculation. ***So the meaning of Planck mass is that it is the mass of one ray or one flux tube of proper length*** c.

IV. FROM STRING THEORY POINT OF VIEW

The area of a string is given by the following equation.

$$\alpha' = \frac{1}{2\pi T_0 \hbar c} \tag{11}$$

Having known the energy at one AU/ray from the previous section, T_0 is calculated as given below.

$$T_0 = E_p^2 = 3.82654139 \times 10^{18} \tag{12}$$

$$\alpha^{'} = \frac{1}{2\pi T_0 \hbar c} = 1.31558591 \times 10^6 \tag{13}$$

There exists a difference between the area given by Eq.(9) and the above equation. With the area given by Eq.(13), the solar constant is derived in the following equation.

$$c_p = \frac{E_p}{\alpha'} = 1486.90376 W/m^2 \tag{14}$$

But the measured value of solar constant is $1366 W/m^2$. Then why is the difference?. Because in my opinion, string theory over estimates the area and hence the subtended angle.

V. REVISED PLANK VOLTAGE AND CURRENT

As shown in Fig.(2), one wave packet's mass is equal to G/c^2 and one wave packet charge is equal to q_p. Because one wave packet's mass is slightly lesser than the mass of proton and greater than the mass of electron, it's charge can be assumed as q_p. Like this how many wave packets will be there in one ray of c length. With reference to Fig.(2), the frequency denoted by f and is given by the following equation.

$$f = \sqrt{\frac{\hbar c}{G}} \div \frac{G}{c^2} = 2.93143959 \times 10^{19} \tag{15}$$

This frequency f is also universal constant. The current is given by the following equation.

$$I_{pr} = q_p \times f = 5.49804949 \times 10^{1} \tag{16}$$

The voltage is defined as the energy per unit charge and is defined in the following equation.

$$V_{pr} = \frac{G}{q_p} = 3.55789746 \times 10^{7} \tag{17}$$

The power is given by the following equation.

$$P_{pr} = V_{pr} I_{pr} = 1.95614963 \times 10^{9} \tag{18}$$

This power is equal to the energy (E_p) contained in a ray of proper length c. The revised Planck impedance is given by the following equation.

$$Z_{pr} = \frac{V_{pr}}{I_{pr}} = 6.48010339 \times 10^{5} \Omega \tag{19}$$

VI. DISCUSSION

Thus the interpretation of Planck mass is justified. Then what is the difference between rays emitted by different stars? This can be explained with the help of Fig.(3). In Fig.(3), the blue ray denotes the light emitted by a neutron star and red ray denotes the light emitted by a main sequence star similar to our sun. From the figure it is clear that the proper length won't change. But radially the distance traversed by the photon do differ and mass of each ray won't change. That is the famous **Planck mass**.

A. Superluminal speed of photons?

Another important question to be asked is that are the photons faster than light (3)?. This question is left wide open. In my opinion, the answer is yes. With reference to Fig.(2), the wave packet (red dot) is not a single particle. It is a composition of N_A number of photons each with mass $\frac{\hbar}{c^2}$. While the red dot traverses along it's proper path it does oscillate. This oscillation (3) produces a velocity over and above the velocity of light on it's path along the proper length. So superluminal velocity is real. It can not be used for communication because alternate wave packet's spin and charge are opposite. If it is not opposite, the universe would have not existed.

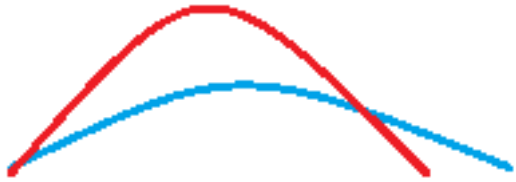

FIG. 3 Light emitted by two different stars

VII. SUPER OSCILLATIONS AND SUPER LUMINAL SPEED OF LIGHT

In string theory the angular momentum is given by the following formula.

$$\frac{J}{\hbar} = \alpha^{'} E \tag{20}$$

If the wave packet in Fig.(2) is assumed as a string, it's angular momentum is given by the following equation. ($\alpha^{'} = 1.13052744 \times 10^{45}$)

$$J = 7.54400961 \times 10^{34} \tag{21}$$

l is given by the following equation.

$$l = \sqrt{\alpha^{'}} = 3.36233169 \times 10^{22} \tag{22}$$

$$v = \frac{J}{ml} = 1.00800168 \times 10^{31} \tag{23}$$

VIII. CONCLUSION

The mass and radius of photon are derived. The importance of Avogadro number from the structure of photon is explained. The Boltzmann constant and the unified mass unit are also derived. The meaning of Planck mass is explained with the derivation of solar constant. One Planck mass is the energy emitted by any **star** per ray of proper length c. The super-luminal speed of photon is explained. The revised Planck voltage, current and impedance are also derived. The constants derived in this manuscript are permutation and combination of Planck units and hence they are also constants by definition. Only correct interpretation is done. For example the Boltzmann constant is obtained by dividing 10 and Avogadro constant because temperature on earth is defined based on the triple point of water. Similarly unified mass unit is derived by multiplying 2 by G/c^2, because on earth, the unified mass unit is defined based on the mass of carbon^{12}. Every constant posses there own measurement uncertainties as well. Even the mass of Higgs ,W, Z boson can also be derived by suitably multiplying G/c^2 with appropriate constants. The electromagnetic ray of proper length c, emitted by a planet or communication antenna is not explained in terms Planck mass. Thus lot of research opportunities left open, for example the ray emitted by a planet.

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