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Intrinsic Spin Angular Momentum of Electron Relation to the Discrete Indivisible Quantum of Time Kshana or Moment

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Abstract

The frequency of any periodic event can be defined in terms of units of Time. Planck constructed a unit of time called the Plank time from other physical constants. Vyasa defined a natural unit of time, kshana, or moment based on the motion of a fundamental particle. It is the time taken by an elementary particle, to change its direction from east to north. According to Vyasa, kshana is discrete, exceedingly small, indivisible, and is a constant time quantum. When the intrinsic spin angular momentum of an electron was related to the angular momentum of a simple thin circular plate, spherical shell, and solid sphere model of an electron, we found that the value of kshana in seconds was equal to ten to a power of minus twenty-one second. The disc model for the spinning electron provides an accurate value of the number of kshanas per second as determined previously and compared with other spinning models of electrons. These results indicate that the disk-like model of spinning electrons is the correct model for electrons. Vyasa's definition of kshana opens the possibility of a new foundation for the theory of physical time, and perspectives in theoretical and philosophical research.

Keywords

Natural Time Unit, Quantum Time Kshana, Plank Time, Intrinsic Angular Momentum, Thin Disc Model, Compton Wavelength

1. Introduction

Time is a parameter used to describe the dynamics. The frequency of any periodic event can be defined in time units. A unit of time can be constructed using other physical constants [1].

Planck constructed a unit of time called Plank time from other physical constant which is $t_p = \sqrt{\hbar G/c^5} = 5.39 \times 10^{-44}$ sec where, c, G, and $\hbar$ are the speed of light, Newton's constant, and Planck's constant respectively [2]. The Planck time is the time taken by the speed of light to travel the Planck length, and the Planck length is the reduced Compton wavelength of the Planck mass. Planck length is the minimum indivisible length interval [3]. Planck Time offers little or no ontological meaning (relating to the branch of metaphysics dealing with the nature of being) to concepts of time, leaving many questions about its usefulness [4]. Determining this time scale is far beyond that of currently available technologies [2].

Heisenberg proposed existence of a fundamental length, λ, and therefore of a fundamental time chronon $\tau = \lambda/c$ [5] [6]. The concept of a quantized unit of interval or space-time s_0, introduced by A. Charlesby, relates to the rest mass m_0 of a particle as $s_0 = h/m_0c^2$. Time and distance between events were also quantized into units t_0 and r_0 respectively [7].

According to the old civilization of India, time is a discrete quantity, constituted of indivisible "present moments" [6] [8]. Maharishi Vyasa defined the quantum of time "kshana" or "moment" which, according to him, is the time taken by an elementary particle to change its direction from East to North. This is the smallest part of time, like an indivisible fundamental particle. Continuous flow of "kshana" one after the other is "krama" or "succession". Combined with the help of intellect, "Moment" and "succession" appear to us as continuous entities like day and night. "Kshana" and "succession" are nothing but creation of mind. Ordinary people cannot differentiate between "kshana" and "succession" due to their inability to concentrate on "Moment" and "succession". To them, both appear to be the same just like "word" and its "referent" [8] [9].

Although not composed of matter or having no material existence, "kshana" is dependent on succession. This phenomenon of succession is referred as "Time". Two "kshana" at a time do not coexist and by succession also they are different, because it is not possible. The succession of "kshana" is nothing but the absence of gap between the earlier and the next "kshana". The present itself is a "kshana". Therefore, there is nothing like the past and future "kshana" or moment. For the same reason, they are not identical. Due to this present "kshana" or "moment" one can see changes in the universe. Every effect in this universe is the outcome of the present "kshana". Therefore, each attribute is dependent on the present "moment". It will be clearly visible if we concentrate on "moment" and its "succession" [8] [9].

The spinning electron model based on Maharishi Vyasa's definition of kshana is successful in explaining most of the properties of the electron such as radius, spin angular momentum, spin magnetic moment, and rest mass. Based on the Maharishi Vyasa's interpretation of kshana as explained above, Wanjerkhede, S. (2022), in case of pair production, found the value of a kshana which is approximately equal to 2×10^{-21} sec, and the radius of the spinning electron or positron is equal to the reduced Compton wavelength [10]. During validation, we also found that, in case of the photoelectric effect, spectral series of hydrogen atoms, Compton scattering, and the statistical concept of motion of electron, the value of the number of kshanas in a second and the value of a kshana is the same as that found in pair production [10].

Spin, a quantum mechanical concept has an intrinsic form of angular momentum carried by elementary particles such as an electron. Butto N. (2021) explain the spin of the electron at the sub-particle level, based on the vortex model of the electron. The electron is described as a superfluid frictionless vortex which has a mass, angular momentum, and spin, and provide a complete explanation of all properties of the electron spinning around its own axis. The direction of the angular momentum of a spinning electron vortex is along the axis of rotation and determined by the direction of spin [11].

2. Methods

Based on the definition of kshana (as defined by Maharishi Vyasa), the number of kshana "n" in a second, the value of a kshana in seconds, and the radius of the fundamental particle, such as an electron, can be determined, as shown here. According to the definition of quantum of time "kshana", which is the time taken by the indivisible fundamental particle to change its direction from east to north is shown in **Figure 1** [8] [11]. Let r_s be the radius of the spinning electron in meters and T_s is the period of spin in seconds. If v is the spinning relativistic velocity of an electron, then:

$$v = c = \frac{2\pi r_s}{T_s} \text{ m/sec} \tag{1}$$

According to Vyasa's definition of kshana, the period of the spinning electron is $T_s' = 4$ kshana. Therefore, the velocity of the spinning electron c'm/kshana, is:

$$v' = c' = \frac{2\pi r_s}{4} = \frac{\pi r_s}{2} \text{ m/kshana} \tag{2}$$

The number of kshanas per second is $n = c/c'$ kshana/sec. By substituting the values of the velocities of light c and c' from Equations (1) and (2) into the Equation (3) for n, we obtain,

$$n = \frac{2c}{\pi r_s} = \frac{1.90853806 \times 10^8}{r_s} \text{ kshana/sec} \tag{3}$$

and

$$1 \text{ kshana} = \frac{1}{n} = \frac{\pi r_s}{2c} = \frac{r_s}{1.90853806 \times 10^8} \text{ sec} \tag{4}$$

and

$$r_s = \frac{1.90853806 \times 10^8}{n} \text{ m} \tag{5}$$

For a Compton radius of electron which is equal to Reduced Compton wavelength ($\lambda^- = \lambda_c/2\pi$), and $\lambda_c = h/mc$ [12] is $r_s = 3.8615926764 \times 10^{-13}$ m [13] [14] [15]. From Equation (3), the number of kshana n is 4.942359849 × 10^{20} kshana, and a kshana is 2.0233249508 × 10^{-21} sec.

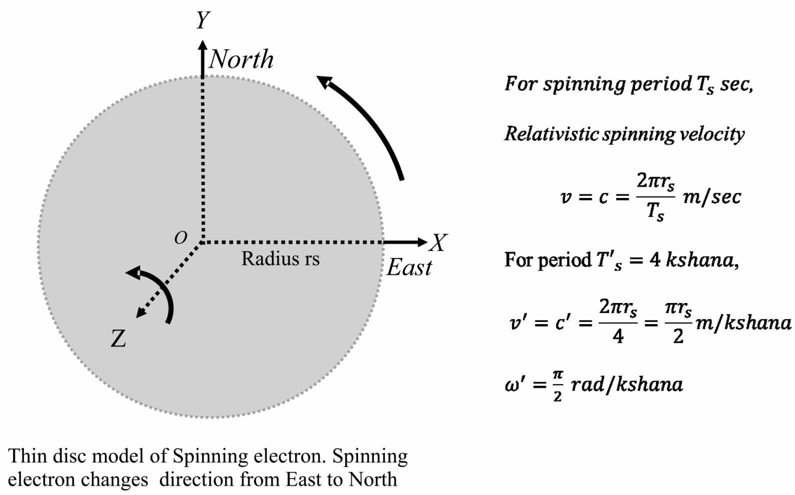

Figure 1. A simple thin circular plate model of spinning electron. Z-axis is the axis of rotation in the anticlockwise direction. T_s is the period of spinning electrons in sec. When the direction changed from east to north, T_s' is equal to 4 kshanas. The relativistic spinning velocity of an electron v is equal to the velocity of light, c. w' rad per kshana is the angular velocity.

In the following subsections, we determine and verify the number of kshanas in one second and the value of one kshana in second using different electron models.

2.1. Intrinsic Spin Angular Momentum of an Electron and Value of a Kshana

An electron has an internal angular momentum, called spin, which contributes to its total angular momentum [16]. The electron spin angular momentum is $S^2 = s(s+1)\hbar^2$. The allowed values of s are 0, 1/2, 1, 3/2, so on. For an electron $s = 1/2$ and the magnitude of its spin angular momentum vector is $|S| = \hbar\sqrt{s(s+1)} = \frac{\sqrt{3}}{2}\hbar$ [11]. The z-component has two possible values $\pm\frac{1}{2}\hbar$ [16] [17].

2.1.1. Angular Momentum of a Simple Thin Circular Plate Model and Intrinsic Spin Angular Moment of Electron

The moment of inertia of a thin disk of mass M and radius R about an axis through the centre and perpendicular to the thin disk is $I = \frac{1}{2}MR^2$ [18]. The angular momentum of the thin disc is $Iw = \frac{1}{2}MR^2w$ (**Figure 1**), where w is the angular velocity of the thin disc [18].

We assume that the electron has a thin, disk-like structure, as shown in **Figure 1**.

Let its intrinsic spin angular momentum $\hbar/2$, is equal to its angular momentum Iw_s, where $I=\frac{1}{2}m_0 r_s^2$ and w_s is the spin angular velocity of the electron [16] [17] [19]. Thus, the intrinsic angular momentum [20]:

$$L=\frac{\hbar}{2}=\frac{1}{2}m_0 r_s^2 w_s \tag{6}$$

where the mass electron at rest is m_0 and its radius is r_s. Rewriting the above equation when the time unit is kshana, we obtain,

$$\frac{\hbar'}{2}=\frac{1}{2}m_0 r_s^2 w_s' \tag{7}$$

where, $\hbar'=\hbar/n$ J.kshana and $w_s'=\pi/2$ rad/kshana and n is the number of kshana in a second. Thus,

$$\frac{\hbar}{2n}=\frac{1}{2}m_0 r_s^2\frac{\pi}{2} \tag{8}$$

But, from Equation (2), $r_s=2c'/\pi$. Therefore,

$$\frac{\hbar}{2n}=\frac{1}{2}m_0\left(\frac{2c'}{\pi}\right)^2\left(\frac{\pi}{2}\right)=\frac{1}{2}m_0\left(\frac{2c}{n\pi}\right)^2\left(\frac{\pi}{2}\right)=\frac{m_0c^2\pi}{n^2\pi^2} \tag{9}$$

Since velocity of light $c'=c/n$ m/kshana, and $m_0c^2=0.511$ MeV, therefore, we have,

$$n=\frac{2m_0c^2}{\pi\hbar}=\frac{1.022\text{ MeV}}{\pi\hbar} \tag{10}$$

$$n=\frac{1.022\times10^6\times1.60217662\times10^{-19}}{\pi\times1.054571800\times10^{-34}}=4.94237\times10^{20}\text{ kshana/sec} \tag{11}$$

Thus, the number of kshanas per second is 4.94237 × 10^{20}, and the value of one kshana, is, 2.02332079 × 10^{-21} s. The spinning period of electron T_s = 4 × 2.02332079 × 10^{-21} = 8.09328316 × 10^{-21} sec. The results obtained for the number of kshana in a second n, and the value of a kshana in a second are the same as those obtained from Equation (3) and in an article published by Wanjerkhede S. M. [10] [21].

Table 1 shows the value of number of kshana "n", and the value of a kshana in second for various methods adopted to find them. Equation in the first row is derived based on Maharishi Vyasa's definition of kshana which is very generic in nature. Value of "n" depends on the radius of the circular orbit. May be a radius of the spinning electron or any other spinning fundamental particle radius or Bohr radius of the first orbit of hydrogen atom [9]. The value of "n" in the second row is when we considered the ratio of spin and orbital periods of hydrogen atom.

Again, re-writing Equation (10) using the mass-energy equivalence relation $E=m_0c^2=h\nu_\gamma$, where ν_γ is the threshold frequency of gamma radiation [20] [22]-[25], we obtain,

$$n=\frac{2h\nu_\gamma}{\pi\hbar}=4\nu_\gamma,\ \text{since } \hbar=\frac{h}{2\pi} \tag{12}$$

$$\nu_\gamma = \frac{n}{4} = 1.2355925 \times 10^{20}\ \text{Hz} \quad (13)$$

$$T_\gamma = \frac{4}{n} = 8.093283 \times 10^{-21} = T_s \quad (14)$$

where, T_γ and T_s are the period of gamma radiation and the spinning period of an electron, respectively. Equation (14) shows that when the gamma radiation disappears, an electron is produced which has the same spinning period [10].

Here, it is worth to note that there is connection between the gamma ray and electron spin. According to Ohanian, H. C., "the spin of the electron may be regarded as an angular momentum generated by a circulating flow of energy in the wave field of the electron [26]" and for Richard Gauthier "The electron is a charged photon" [27].

Table 1. Shows the different methods adopted to find the number of kshana "n", and value of a kshana in seconds.

Basis	Equation for no. of kshana "n"	Number of kshana "n" $\times 10^{20}$ kshanas	Value of a kshana $\times 10^{-21}$ sec
Vyasa's definition [10]	$\frac{2c}{\pi R_s}$	4.942359859	2.0233249470
Orbital & spinning period ratio [10]	$\frac{4}{\alpha^2 T_a}$; $\frac{8R_\infty c}{\alpha^2}$	4.942359859	2.0233249470
Mass-energy equation [21]	$\frac{4m_0c^2}{h}$; $\frac{4c}{\lambda_c}$	4.942359860	2.0233249466
Conservation of momentum [21]	$\frac{2h}{\lambda_\gamma m_0 \pi R_s}$	4.942359859	2.0233249470
Intrinsic angular momentum	$\frac{2m_0c^2}{\pi\hbar}$	4.942359861	2.0233249462

2.1.2. Angular Momentum of a Spherical Shell and Total Spin Angular Momentum

The electron has finite spin angular momentum of $S = \frac{\sqrt{3}}{2}\hbar = \frac{\sqrt{3}h}{4\pi}$ [16] and this spin angular momentum is equal to Iw_s [17] [28], where, I is the moment of inertia of the electron and is equal to $\frac{2}{3}m_0 r_s^2$, whose rest mass is m_0 and revolve around the centre with radius r_s (**Figure 2**).

Equating the total spin angular momentum to the angular momentum of the spherical shell yields,

$$S = \frac{\sqrt{3}h}{4\pi} = \frac{2}{3}m_0 r_s^2 w_s \quad (15)$$

The above equation is expressed in time unit kshana, as shown in **Figure 2**. We get,

$$S=\frac{\sqrt{3}h'}{4\pi}=\frac{2}{3}m_0r_s^2w_s' \tag{16}$$

Substituting for $h'=h/n$, $w_s'=\pi/2$, and r_s from Equation (5), we have

$$\frac{\sqrt{3}h}{4\pi n}=\frac{2}{3}m_0r_s^2\frac{\pi}{2}=\frac{\pi m_0}{3}\left(\frac{1.90853806\times10^8}{n}\right)^2 \tag{17}$$

Now, number of kshana n in a second will be,

$$n=\frac{4\pi^2m_0\left(1.90853806\times10^8\right)^2}{3\sqrt{3}h}=3.8046303796\times10^{20}\ \text{kshana/sec} \tag{18}$$

Thus, the number of kshanas in a second $n=3.804630379\times10^{20}$ kshana and $1\ \text{kshana}=2.628376\times10^{-21}\ \text{s}$.

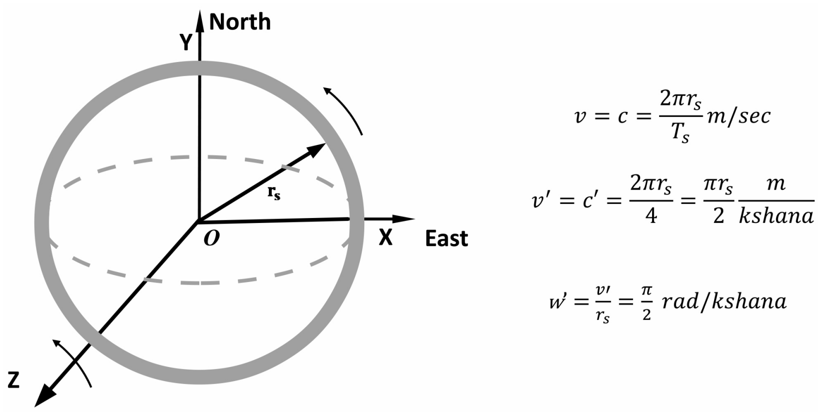

Figure 2. Spherical shell model of a spinning electron which changes its direction from east to north.

2.1.3. Angular Momentum of a Spherical Shell and z-Component of Spin Angular Momentum

The z-component of spin angular momentum of an electron is $\frac{1}{2}\hbar$. The relationship between velocity v and angular momentum for a spherical shell of mass m_0 and radius r_s was $\frac{2}{3}m_0vr_s$ [28]. For a spherical shell, the moment of inertia is $\frac{2}{3}m_0r_s^2$ [16] [17]. By equating the angular momentum of a spherical shell and the z-component of the spin angular momentum, we obtain:

$$S=\frac{h}{4\pi}=\frac{2}{3}m_0r_s^2w_s \tag{19}$$

Re-writing Equation (19) when time is in kshana, we have:

$$S=\frac{h'}{4\pi}=\frac{2}{3}m_0r_s^2w_s' \tag{20}$$

Substituting for $h'=h/n$, $w_s'=\pi/2$, and r_s, we get,

$$n=\frac{4\pi^2m_0\left(1.90853806\times10^8\right)^2}{3h}=6.589813\times10^{20}\ \text{kshana/sec} \tag{21}$$

Thus, the number of kshanas in the second $n = 6.589813 \times 10^{20}$ kshana and $1\,\text{kshana} = 1.5174937 \times 10^{-21}$ s. The average value of Equations (18) and (21) for the number of kshanas in a second is $n = 5.1972216895 \times 10^{20}$ kshana which is the same as that shown in Equation (11) and is in good agreement with the values found in a previously published article [10].

2.1.4. The Angular Momentum of a Solid Sphere and the Total Spin Angular Moment

Following **Figure 3** shows the solid sphere spinning around the z-axis.

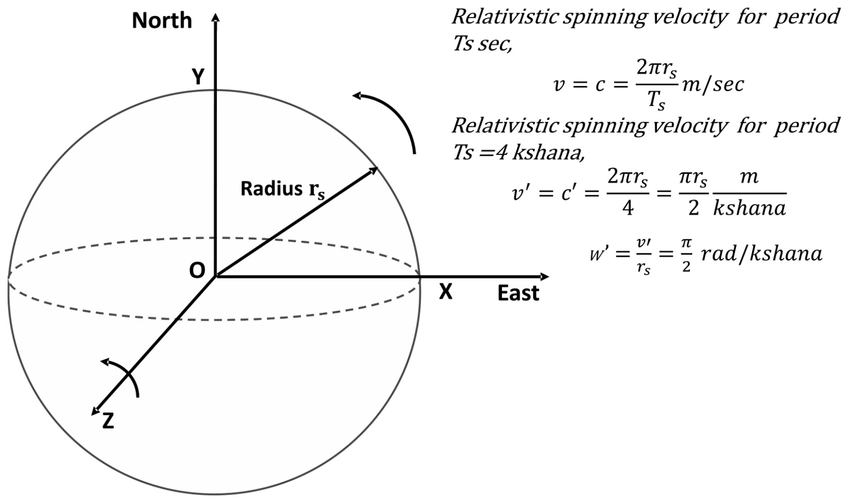

Figure 3. Solid spherical model of a spinning electron.

Again, let the spin angular momentum $\frac{\sqrt{3}h}{4\pi}$ be equal to the angular momentum $\frac{2}{5} m_0 r_s^2 w_s$, where the angular frequency is w_s rad/sec, and the moment of inertia is $I = \frac{2}{5} m_0 r_s^2$. Therefore,

$$\frac{\sqrt{3}h}{4\pi} = \frac{2}{5} m_0 r_s^2 w_s \tag{22}$$

Now, substituting the value of r_s from Equation (3) in Equation (22) in which the angular frequency w rad/sec is w' rad/kshana, and the Planck constant h J.sec is h' J.kshana, we have,

$$\frac{\sqrt{3}h'}{4\pi} = \frac{2}{5} m_0 r_s^2 \frac{\pi}{2} = \frac{\pi m_0 r_s^2}{5} \tag{23}$$

$$\frac{\sqrt{3}h}{4\pi n} = \frac{\pi m_0}{5} \left(\frac{1.90853806 \times 10^8}{n} \right)^2 \tag{24}$$

where, $n = h/h'$ sec/kshana. Solving the above for n, we have,

$$n = \frac{4\pi^2 m_0 \left(1.90853806 \times 10^8\right)^2}{5\sqrt{3}h} \tag{25}$$

$$n = \frac{4\pi^2 m_0 \left(1.90853806 \times 10^8\right)^2}{5\sqrt{3}h} = 2.28277822775 \times 10^{20} \text{ kshana/sec} \tag{26}$$

Thus, the number of kshanas in a second $n = 2.2827782277 \times 10^{20}$ kshana, and $1\,\text{kshana} = 4.3806270 \times 10^{-21}\,\text{s}$.

2.1.5. Equating the Angular Momentum of a Solid Sphere with the z-Component of the Spin Angular Moment

The Z-component of the spin angular moment is $\hbar/2$, and the resulting equation for n is:

$$\frac{h'}{4\pi} = \frac{2}{5} m_0 r_s^2 \frac{\pi}{2} = \frac{\pi m_0 r_s^2}{5} \tag{27}$$

$$n = \frac{4\pi^2 m_0 \left(1.90853806 \times 10^8\right)^2}{5h} = 3.953887872 \times 10^{20} \text{ kshana/sec} \tag{28}$$

Thus, the number of kshanas in a second $n = 3.953887872 \times 10^{20}$ kshana and the value of a kshana is $1\,\text{kshana} = 2.52915619 \times 10^{-21}\,\text{sec}$. The average value of n is equal to $3.11833304985 \times 10^{20}$ which is much lower than the results obtained previously, where the number of kshana $n = 4.942359849 \times 10^{20}$ kshana, and a kshana is $2.0233249508 \times 10^{-21}$ sec (as shown in Equation (3)) [10].

3. Results

3.1. Validation of Kshana

Validation of kshana in seconds is described in the following subsections.

3.1.1. Classical Electron Model of Spin, Kshana and Reduced Compton Wavelength

The spin angular frequency of the electron, in a semi-classical model, is related to its rest energy by $\hbar w_s = m_0 c^2$ and the relativistic velocity $v = c = w_s r_s$, where w_s is the angular frequency (and c is the velocity of light with which it is spinning) of the spinning electron with a mass of m_0 [19] [29]. Thus, the radius of the electron is:

$$r_s = \frac{\hbar}{m_0 c} = \lambda_c' \tag{29}$$

where, λ_c' denotes the reduced Compton wavelength. For the simple thin circular plate model of Zhao (2017), the electron radius being $r_s = \lambda_c'$, and the spin angular momentum [19] are

$$J = \frac{m_0 r_s^2 w_s}{2} = \frac{\hbar}{2} \tag{30}$$

$$m_0 r_s^2 w_s = \hbar = \frac{h}{2\pi} \tag{31}$$

When time is in kshana, $w_s = \frac{\pi}{2}$ and $h' = h/n$, where

$n = 4.96240709788 \times 10^{20}$ (see Equations (3) and (11)) is the number of kshana in a second, then we have,

$$m_0 r_s^2 w_s' = \frac{h'}{2\pi} \tag{32}$$

$$m_0 r_s^2 \frac{\pi}{2} = \frac{h}{2n\pi} \tag{33}$$

$$r_s^2 = \frac{h}{n\pi^2 m_0} \tag{34}$$

$$r_s = \sqrt{\frac{h}{n\pi^2 m_0}} \tag{35}$$

Substituting the values of h, n, and m_0 we have,

$$r_s = \sqrt{\frac{6.626070040 \times 10^{-34}}{4.96240709788 \times 10^{20} \pi^2 \times 9.10938356 \times 10^{-31}}} \tag{36}$$

$$r_s = 3.8537847098 \times 10^{-13} \text{ m} \tag{37}$$

The radius of the electron is equal to the reduced Compton wavelength, which confirms the accuracy of the kshana.

3.1.2. Electron-Positron Pair Generation and Kshana

In electron-positron pair generation, the threshold energy of the gamma radiation required is 1.022 MeV and for electron generation the gamma ray energy is 0.511 MeV [30] [31]. The frequency of gamma radiation is,

$$\nu_\gamma = \frac{0.511}{h} = 1.233914 \times 10^{20} \text{ cps} \tag{38}$$

where h is Planck constant. The period $T_\gamma = \frac{1}{\nu_\gamma} = 8.104293 \times 10^{-21}$ sec and wavelength λ_γ are,

$$\lambda_\gamma = \frac{c}{\nu_\gamma} = 2.42960597 \times 10^{-12} \text{ m} \tag{39}$$

If r_s is the radius of the spinning electron, the relativistic spinning velocity of the electron is $v' = c'$ m per kshana. According to Vyasa's definition of kshana-, (**Figure 1**), is given by the following equation:

$$v' = c' = \frac{2\pi r_s}{T_s} = \frac{\pi r_s}{2} \text{ m/kshana} \tag{40}$$

where, the electron spinning period is $T_s = 4$ kshana. However, $c' = \nu_\gamma' \lambda_\gamma$, assuming that the period of gamma radiation is equal to the spinning period of the electron that is, $T_\gamma = T_s$ (Equation (14)). The attribute of the cause was found to be present in the effect [10] [32]. Therefore, in this study, it is assumed that the period (an attribute) of the spinning electron or positron (effect) is the same as that of the photon (cause) [10] [32]. From the above equation, we obtain the following:

$$c' = \frac{\lambda_\gamma}{T_\gamma} = \frac{\lambda_\gamma}{4} = \frac{\pi r_s}{2} \text{ or } \lambda_\gamma = 2\pi r_s \tag{41}$$

Thus, the circumference $2\pi r_s = \lambda_\gamma$, and the radius of the electron is $r_s = \lambda_\gamma / 2\pi$ [10]. Keeping the value of λ_γ of Equation (39) in Equation (41), we obtain:

$$r_s = \frac{\lambda_\gamma}{2\pi} = \frac{2.42960597 \times 10^{-12}}{2\pi} = 3.86683799 \times 10^{-13}\ \text{m} \tag{42}$$

This indicates that the radius r_s of the spinning electron is consistent with the Compton radius [13]. Now, if n is the number of kshanas in a second, then from the above equation, we obtain:

$$n = \frac{c}{c'} = \frac{2c}{\pi r_s} = \frac{2c2\pi}{\pi \lambda_\gamma} = \frac{4c}{\lambda_\gamma} = 4.9356556 \times 10^{20}\ \text{kshana} \tag{43}$$

Therefore, $1\,\text{kshana} = 1/n = 2.02607329 \times 10^{-21}\,\text{sec}$. Again, this shows that the value of the number of kshana n in a second and the value of a kshana in seconds are in good agreement with the values previously determined in the article [10].

3.1.3. Superfluid Frictionless Vortex Model of Electron and Quantum Time Kshana

Electron spin is the particles' intrinsic angular momentum S given by the equation

$$S = \hbar\sqrt{s+1} \tag{44}$$

where, $s = n/2$, and n is any non-negative integer [11]. In hydrodynamics, the magnitude of the angular momentum of the vortex L is proportional to moment of inertia I and angular speed ω radians per second. Therefore,

$$L = I\omega \tag{45}$$

The angular momentum of the vortex L is the angular momentum relative to the centre. For a single particle $I = r_s^2 m_0$ and $\omega = c/r_s$ for circular motion [11]. Now, angular momentum is:

$$L = \frac{r_s^2 m_0 c}{r_s} = r_s m_0 c \tag{46}$$

where r_s is the radius of the vortex, and m_0 is the electron rest mass. Equating above Equation (46) to $S = \hbar\sqrt{s+1}$, for $s = 0$, we have,

$$\hbar = r_s m_0 c \tag{47}$$

When time unit is kshana, we have,

$$\hbar' = r_s m_0 c' \tag{48}$$

Substituting the relativistic spinning velocity $c' = \pi r_s / 2$ meter/kshana in the above Equation (48), we get,

$$\hbar' = \frac{m_0 \pi r_s^2}{2} \tag{49}$$

Since $\hbar' = h'/2\pi$

$$\frac{h'}{2\pi} = \frac{m_0 \pi r_s^2}{2} \tag{50}$$

$$h' = m_0 \pi^2 r_s^2 = 1.340669281507 \times 10^{-54} \text{ joule} \cdot \text{kshana} \quad (51)$$

Alternatively, we find h' as shown below: The velocity of the fluid element instantaneously passing through a given point in space in the vortex with radius r_s is constant in time; therefore, the circulation or the vorticity $\tau = 2\pi r_s c$ is constant, where c is the speed of light. For electron mass m_0, conserved momentum is $m_0 \tau$. Therefore, $2\pi r c m_0$ is constant, which equal to the Planck constant [11]. Thus,

$$h = 2\pi m_0 r_s c \quad (52)$$

Rewriting the above Equation (52) when time unit is kshana, we have,

$$h' = 2\pi m_0 r_s c' \quad (53)$$

From Equation (2), where c' is the relativistic spinning velocity.

$$c' = \frac{\pi r_s}{2} \quad (54)$$

Substituting this relativistic spinning velocity in the above Equation (54), we get

$$h' = 2\pi m_0 r_s \frac{\pi r_s}{2} = \pi^2 m_0 r_s^2 \quad (55)$$

$$h' = \pi^2 m_0 r_s^2 = 1.340669281507 \times 10^{-54} \quad (56)$$

Now, the value of number of kshana in a second is:

$$n = \frac{h}{h'} = \frac{6.626070040 \times 10^{-34}}{1.340669281507 \times 10^{-54}} = 4.94235985816 \times 10^{20} \text{ kshana} \quad (57)$$

Thus, the value of n is same as previously found by Wanjerkhede S. M. as shown in **Table 1** [10] [21].

4. Discussion

The quantum time unit kshana or moment is much more human-oriented, meaningful, constant, discrete, exceedingly small, cannot be further divided, and is independent of external perturbations as compared with the time unit second. For ordinary people, the time appears to be smooth and continuous, similar to "day and night". However, time does not flow continuously. This is neither smooth nor continuous. According to Vyasa, the quantum of time is discrete [9]. The value of a "kshana" found is of the order of 10^{-21} sec which is still large as compared with quantum time chronon (6.266 × 20^{-24} sec) [6] [33] and Planck time ($t_p = \sqrt{\frac{G\hbar}{c^5}} = 5.391247 \times 10^{-44}$ sec) [34].

When kshana is compared to Compton time, Compton time is larger than the kshana. The Compton time is the time for a photon to travel the Compton wavelength. Mathematically it is $t_c = \lambda_c / c$ sec. Where, t_c is Compton time, λ_c is Compton wavelength, c is the speed of light. The reduced Compton time t_c^- is λ_c^- / c [35]. The Compton time t_c is related with quantum time kshana as shown here,

$$t_c = \frac{\lambda_c}{c} = \frac{2\pi r_s}{nc'} = \frac{4\pi r_s}{n\pi r_s} = \frac{4}{n} = 4t_k \tag{58}$$

where, $r_s = \lambda_c/2\pi$, $c' = \pi r_s/2$, $n = c/c'$, and quantum time kshana $t_k = 1/n$ (Equations (2), (3), (4), and (29)). However, quantum time kshana is very large as compared to the reduced Compton time for the critical Friedmann mass in the Hubble sphere which is 1.26×10^{-104} sec [35].

Kshana is dependent on the radius of the electron (Equation (3)), it can take any smaller value, even smaller than the Planck time [9]. For example, for radius of graviton $r_G = 1.36916312 \times 10^{-76}$ m, the value of kshana is $1\,\text{kshana} = 1/n = \frac{r_G}{1.90853806 \times 10^{8}} = 7.17388428 \times 10^{-85}\,\text{sec}$ [9] [36]. Thus, quantum time "kshana" based on spinning period of electron, is a natural unit of time.

We calculated the value of kshana with different models of spinning electrons as discussed above and found that a simple thin circular plate model along the z—axis provides accurate results for kshana compared with the spinning solid sphere and shell model. Thus, Maharishi Vyasa's definition of kshana helps us understand the nature and structure of electrons.

5. Conclusion

The quantum time kshana is a natural unit of time, such as day and night, based on the rotation of the Earth on its axis. Value of a kshana found by a fundamental process, such as spinning, rather than by a length coordinate is proportional to the radius of the fundamental particle such as electron, and it decreases with the decreasing radius. According to Maharishi Vyasa, a kshana is exceedingly small, indivisible, and constant. Therefore, more research on this natural unit of time kshana is possible in future. Maharishi Vyasa's definition of kshana opens the possibility of a new foundation for the theory of physical time, and new perspectives in theoretical and philosophical research. "Kshana" which is in zepto-second, that may be achieved with any direct measurement.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Bergquist, J.C., Jefferts, S.R. and Wineland, D.J. (2001) Time Measurement at the Millennium. *Physics Today*, **54**, 37-42. https://doi.org/10.1063/1.1366066

[2] Wendel, G., Martínez, L. and Bojowald, M. (2020) Physical Implications of a Fundamental Period of Time. *Physical Review Letters*, **124**, Article ID: 241301. https://doi.org/10.1103/physrevlett.124.241301

[3] Haug, E.G. (2022) God Time = Planck Time: Finally Detected! 1-12. https://hal.science/hal-03769825v2/document

[4] Humpherys, D. (2022) The Implicit Structure of Planck's Constant. *European Journal of Applied Physics*, **4**, 22-25. https://doi.org/10.24018/ejphysics.2022.4.6.227

[5] Caldirola, P. (1977) The Chronon and Uncertainty Relations in the Theory of the Excited-Mass States of the Electron. *Lettere al Nuovo Cimento*, **20**, 632-634. https://doi.org/10.1007/bf02812995

[6] Caldirola, P. and Erasmo, R. (1978) The Concept of Time in Physics. *Epistemologia*, **1**, 263-304.

[7] Charlesby, A. (1995) Waves and Particles—Quantisation of the Interval between Eventss0. *Radiation Physics and Chemistry*, **45**, 175-186. https://doi.org/10.1016/0969-806x(94)00085-9

[8] Patanjali, M. (2003) Patanjal Yoga Darashanm. Aarsha Gurukul Mahavidhyalaya, 2 edition.

[9] Wanjerkhede, S.M. (2023) Kshana—The Smallest Mysterious Unit of Time Exploring the Temporal Variation of Fine Structure Constant. In: Purenovic, J., Ed., *Fundamental Research and Application of Physical Science*, Vol. 8, B P International, 94-112. https://doi.org/10.9734/bpi/fraps/v8/6994a

[10] Wanjerkhede, S.M. (2022) Exceedingly Small Quantum of Time Kshana Explains the Structure of an Electron. *Journal of Modern Physics*, **13**, 1167-1183. https://doi.org/10.4236/jmp.2022.138068

[11] Butto, N. (2021) A New Theory for the Essence and Origin of Electron Spin. *Journal of High Energy Physics*, *Gravitation and Cosmology*, **7**, 1459-1471. https://doi.org/10.4236/jhepgc.2021.74088

[12] Compton, A.H. (1923) A Quantum Theory of the Scattering of X-Rays by Light Elements. *Physical Review*, **21**, 483-502. https://doi.org/10.1103/physrev.21.483

[13] Mohr, P.J., Newell, D.B. and Taylor, B.N. (2016) CODATA Recommended Values of the Fundamental Physical Constants: 2014. *Journal of Physical and Chemical Reference Data*, **45**, Article ID: 043102. https://doi.org/10.1063/1.4954402

[14] Newell, D.B. and Tiesinga, E. (2019) NIST Special Publication 330, the International System of Units (SI). 2019 Edition, Bureau International des Poids et Mesures.

[15] Shulman, M.E. (2017) On the Structure of Electrons and Other Charged Leptons. *Journal of High Energy Physics*, *Gravitation and Cosmology*, **3**, 503-521. https://doi.org/10.4236/jhepgc.2017.33039

[16] Schroeder, D.V. (2022) Notes on Quantum Mechanics. Weber State University.

[17] Cresser, J.D. (2011) Particle Spin and the Stern-Gerlach Experiment.

[18] Brown, R.G. (2013) Introductory Physics I Elementary Mechanics, Vector Torque and Angular Momentum.

[19] Zhao, H. (2017) Quantum Mechanical Calculation of Electron Spin. *Open Physics*, **15**, 652-661. https://doi.org/10.1515/phys-2017-0076

[20] Garrigues, J. (2019) Discrete Model of Electron. 1-24. https://doi.org/10.13140/RG.2.2.28408.49920

[21] Wanjerkhede, S.M. (2024) Kshana: An Exceedingly Small, Constant, Discrete, and Indivisible Quantum of Time in Ancient Indian Philosophy and Its Relation to Einstein's Equation $E = mc^2$. In: Purenovic, J., Ed., *Current Perspective to Physical Science Research*, Vol. 7, B P International, 84-104. https://doi.org/10.9734/bpi/cppsr/v7/8706a

[22] Williams, E.J. (1935) Production of Electron-Positron Pairs. *Nature*, **135**, 66-66. https://doi.org/10.1038/135066a0

[23] Fernflores, F. (2019) The Equivalence of Mass and Energy. In: Zalta, E.N., Ed., *The Stanford Encyclopedia of Philosophy*, Fall 2019 Edition, Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/fall2019/entries/equivME/

[24] Qian, W. (2023) A Physical Interpretation of Mass-Energy Equivalence Based on the Orthogonal Collision. *Journal of Modern Physics*, **14**, 1067-1086. https://doi.org/10.4236/jmp.2023.147059

[25] Reed, L. (2022) Pair Production and Annihilation. 4th Edition, Booklocker.

[26] Ohanian, H.C. (1986) What Is Spin? *American Journal of Physics*, **54**, 500-505. https://doi.org/10.1119/1.14580

[27] Gauthier, R. (2014) The Electron Is a Charged Photon. *The General Science Journal*, 1-12. https://www.gsjournal.net/Science-Journals/Research%20Papers/View/5715

[28] Sebens, C.T. (2019) How Electrons Spin. *Studies in History and Philosophy of Science Part B*: *Studies in History and Philosophy of Modern Physics*, **68**, 40-50. https://doi.org/10.1016/j.shpsb.2019.04.007

[29] Torres-Silva, H. (2008) Spin and Relativity: A Semiclassical Model for Electron Spin. *Ingeniare*. *Revista chilena de ingeniería*, **16**, 72-77. https://doi.org/10.4067/s0718-33052008000400011

[30] Hubbell, J.H. (2006) Electron-Positron Pair Production by Photons: A Historical Overview. *Radiation Physics and Chemistry*, **75**, 614-623. https://doi.org/10.1016/j.radphyschem.2005.10.008

[31] Parks, J.E. (2015) The Compton Effect-Compton Scattering and Gamma Ray Spectroscopy.

[32] Kanaada, M. (2014) Vaisesika Darashanm. Arshya Vidhya Prachara Nyasa, 1 edition.

[33] Farias, R.H.A. and Recami, E. (2010) Introduction of a Quantum of Time ("Chronon"), and Its Consequences for the Electron in Quantum and Classical Physics. In: Hawkes, P.W., Ed., *Advances in Imaging and Electron Physics*, Elsevier, 33-115. https://doi.org/10.1016/s1076-5670(10)63002-9

[34] Haug, E.G. (2020) Finding the Planck Length Multiplied by the Speed of Light without Any Knowledge of G, c, or h, Using a Newton Force Spring. *Journal of Physics Communications*, **4**, Article ID: 075001. https://doi.org/10.1088/2399-6528/ab9dd7

[35] Haug, E.G. (2024) God Time = Planck Time: Finally Detected! And Its Relation to Hubble Time. *Open Journal of Microphysics*, **14**, 40-66. https://doi.org/10.4236/ojm.2024.142004

[36] Balseanu, M. (2019) Graviton Physics. 1-57. https://doi.org/10.13140/RG.2.2.10316.87686/2

Notation List of the Variables of the Work

t_p sec	Planck time
$\hbar$ Joule.sec	Planck constant
G	Newton's gravitational constant
c m/sec	speed of light
c' m/kshana	speed of light
I	moment of inertia
m_0 Kg	rest mass of electron
r_s meter	radius of electron
n kshana	number of kshana in a second
w_s rad/sec	angular velocity
w_s' rad/kshana	angular velocity
T_s sec	spinning period of electron
T_s' kshana	spinning period of electron
v m/sec	relativistic spinning velocity of electron
v' m/kshana	relativistic spinning velocity of electron
R m	radius of the disc
ν_γ' cycle/kshana	gamma radiation frequency
λ_γ cycle/sec	gamma radiation frequency
λ_γ m	wavelength of gamma radiation
T_γ sec	period of gamma radiation