Journal of Modern Physics, 2022, 13, 1167-1183
https://www.scirp.org/journal/jmp
ISSN Online: 2153-120X
ISSN Print: 2153-1196

Exceedingly Small Quantum of Time Kshana Explains the Structure of an Electron

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How to cite this paper: 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

Received: July 3, 2022
Accepted: August 13, 2022
Published: August 16, 2022

Abstract

In this study, an effort is made to find the attributes of an electron based on Maharishi Vyasa's definition of kshana or moment. Kshana or moment is a very small quanta of time defined by Maharishi Vyasa. It is the time taken by an elementary particle to change the direction from east to north. It is found that the value of a kshana in the case of pair production is approximately 2×10^{-21} sec, and the radius of the spinning electron or positron is equal to the reduced Compton wavelength. The mass of the electron is equal to the codata recommended value of electron mass and time required in pair production is about four kshanas equal to spinning period of an electron. During validation, 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 is the same as that found in pair production.

Keywords

Kshana, Pair Production, Photoelectric Effect, Compton Scattering, Fine Structure Constant

1. Introduction

In this paper, my effort is to find some attributes of electrons based on Maharishi Vyasa's definition of kshana or moment, exceedingly small quanta of time [1] [2]. The attributes of electrons include spin, magnetic moment, fine structure constant α, anomalous magnetic moment, and charge quantization. Various physical parameters of the electron such as charge, mass, as well as the spin angular momentum and the magnetic moment have been measured with great precision [3]. Different properties of electrons have revealed some facts about their size and shape [4].

The radius of electron is the key problem in elementary particle physics [5]. Researchers have made various approaches to give the exact value to its radius. Various theoretical and experimental results show that there are eight diverse types of radii of an electron [4].

For example, classical electron radius, Compton radius (electron), electromagnetic radius (electron) etc. [4]. In the paper, Compton radius of electron is discussed. The radius of the electron is found based on Maharishi Vyasa's definition of kshana [1] [2], where kshana is a very small and indivisible unit of time, and Maharishi Kanada's thought on "cause and effect". Maharishi Kanada says that "the attribute of the cause is found to be present in the effect" ("Kaaranagunapurvakaha kaaryaguno drasthaha" 2.1.24) [6]. Therefore, in case of pair production, in the article, it is assumed that (1) the time period (an attribute) of spinning electron or positron (effect) is the same as that of photon (cause), and (2) electron and positron spin with a relativistic velocity of light [7].

2. Definition of a Very Small Unit Time "Kshana" or "Moment"

Maharishi Vyasa, in his commentary on Patanjali Yoga Sutra, defined a very small unit of time called "kshana" or "moment", which is very small and indivisible [1]. According to him, it is the time taken by an elementary particle to change its direction from east to north [2]. Here, in the article, we assumed that the elementary particle is a spinning electron, as shown in **Figure 1**. When a spinning electron changes direction from east to north, the time taken is "t" units. Then, velocity is

$$v' = \frac{\theta R_s}{t}\ \text{m/kshana} \tag{1}$$

where "R_s" is the radius of the spinning electron. According to the Maharishi Vyasa's time, "t" is one "kshana," and $\theta = 90^\circ = \pi/2$ radians, as shown in **Figure 1**. Hence

$$v' = \frac{90^\circ \times R_s}{1} = \frac{\pi \times R_s}{2}\ \text{m/kshana} \tag{2}$$

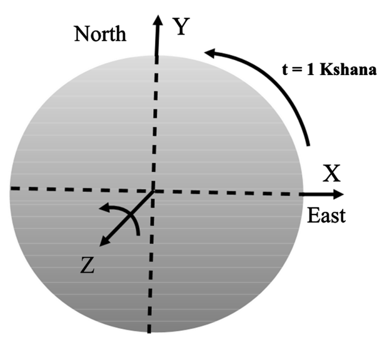

Figure 1. Z is the axis of rotation of a spinning electron, and it changes its direction from east to north. The time taken to change the direction is $t = 1$ kshana, and for one complete rotation time taken is $T_s = 4$ kshanas.

Similarly, the angular velocity ω' is

$$\omega' = \frac{\theta}{t} = \frac{90^\circ}{1} = \frac{\pi/2}{1} = \frac{\pi}{2} \text{radian/kshana} \tag{3}$$

Substituting the value of π, we obtain ω' = 1.570796326794 radian/kshana. Angular velocity ω' is a constant velocity since π is a constant quantity [2]. Rewriting the Equation (3)

$$1 \text{ Moment or kshana} = \frac{\pi/2}{\omega'} = \frac{1.570796326794}{1.570796326794} \tag{4}$$

Thus, 1 moment or 1 kshana is the time taken by a fundamental particle to describe an angle of 90˚ or π/2 radians while changing the direction from "East" to "North" and is just a constant independent of any external forces. Then, from Maharishi Vyasa's definition of kshana [2], we have

$$v' = c' = \frac{2\pi R_s}{T_s} = \frac{2\pi R_s}{4} = \frac{\pi R_s}{2} \text{meter/kshana} \tag{5}$$

where c' meter/kshana is the relativistic velocity of the spinning electron, $T_s = 4$ kshanas is the time period, and R_s meters is the radius of the spinning electron. The spinning velocity of electrons is equal to the relativistic velocity of light [7] [8]. Therefore, it is assumed that the electron spins with the velocity of light [7].

3. Determination of Number of Kshana in a Second

3.1. Method 1

If there are "n" kshana in a second, then from Equation (5), "n" can be found as shown below:

$$n = \frac{c \text{ m/sec}}{c' \text{ m/kshana}} = \frac{2c}{\pi R_s} \text{kshana/sec} \tag{6}$$

where c is the velocity of light in meters/second and c' is the velocity of light in meters/kshana. Alternatively, we can find the number of kshanas "n" in a second, as shown below:

$$1 \text{ kshana} = \frac{T_s}{4} = \frac{2\pi R_s}{4c} = \frac{\pi R_s}{2c} \text{sec} \tag{7}$$

where spinning time period $T_s = 2\pi R_s/c$ sec and 1 kshana = $1/n$ sec. Therefore,

$$n = \frac{2c}{\pi R_s} \text{kshana/sec} \tag{8}$$

Equation (8) is like the Equation (6). Substituting the values for c and π, we have

$$n = \frac{1.9085380 \times 10^8}{R_s} \text{kshana/sec} \tag{9}$$

Thus, the number of kshanas "n" in a second is reciprocally related to the radius of the spinning electron R_s.

3.2. Method 2

If T_a is the time period of the electron in the first orbit of the hydrogen atom in sec and T_s is the time period of spinning electrons in sec, then the ratio of time periods is

$$\frac{T_a}{T_s}=\left(\frac{2\pi R_a}{v}\right)\Big/\left(\frac{2\pi R_s}{c}\right)=\frac{R_a c}{R_s v}=\frac{R_a}{\alpha R_s} \tag{10}$$

where R_a, R_s, v, c, and α are the radius of the first orbit of the hydrogen atom in meters, radius of the spinning electron in meters, orbital velocity of the electron in the first orbit of the hydrogen atom in meters per sec, velocity of light in meters per sec, and fine structure constant, respectively. The fine structure constant is $\alpha = v/c$. Rewriting the above equation when time periods $T'_a = nT_a$ and $T'_s = nT_s$ are in kshana, velocities $v' = v/n$ and $c' = c/n$ are in meters/kshana.

$$\frac{T'_a}{T'_s}=\left(\frac{2\pi R_a}{v'}\right)\Big/\left(\frac{2\pi R_s}{c'}\right)=\frac{R_a c'}{R_s v'}=\frac{R_a}{\alpha R_s} \tag{11}$$

where the fine structure constant is also $\alpha = v'/c'$ [2]. If there are "n" kshanas in a second, then 1 sec = n kshanas. Thus, from Equation (11), we have

$$\frac{T'_a}{T'_s}=\frac{nT_a}{T'_s}=\frac{R_a}{\alpha R_s} \tag{12}$$

where orbital time period $T'_a = nT_a$ kshanas and spinning time period $T'_s = nT_s = 4$ kshanas. Rewriting the above equation, we have

$$\frac{nT_a}{4}=\frac{R_a}{\alpha R_s} \tag{13}$$

$$n=\frac{4R_a}{\alpha T_a R_s} \tag{14}$$

But time period for the Bohr first orbit (n = 1), is $T_a = 4\varepsilon_0^2 h^3 / m_0 e^4$ [2] [9]. Substituting this in Equation (14) we have

$$n=\frac{4R_a m_0 e^4}{\alpha 4\varepsilon_0^2 h^3 R_s} \tag{15}$$

But Rydberg constant $R_\infty = m_0 e^4 / 8\varepsilon_0^2 h^3 c$ [2] [9]. Therefore,

$$n=\frac{8R_a c m_0 e^4}{\alpha R_s 8\varepsilon_0^2 h^3 c}=\frac{8R_a R_\infty c}{\alpha R_s}=\frac{k}{R_s} \tag{16}$$

where, $k = 8R_a R_\infty c/\alpha$. Substituting the Bohr radius $R_a = 0.52917721 \times 10^{-10}$ meters, Rydberg constant 10.97373156×10^6/meters, velocity of light $c = 2.99792458 \times 10^8$ meters/sec, and fine structure constant $\alpha = 7.29735256 \times 10^{-3}$ [10], we get $k = 1.90853806 \times 10^8$. Thus, number of kshanas in a second will be

$$n=\frac{1.9085380\times 10^8}{R_s}\,\text{kshana/sec} \tag{17}$$

Equation (17) is similar to Equation (9) and 1 kshana = $1/n = 0.52396125 \times 10^{-8} R_s$ sec. Thus, the number of kshanas in a second is inversely proportional to the radius of the spinning electron. However, the value of a "kshana" determined based on the radius of the first orbit of the hydrogen atom is comparatively large [2], and for a large radius, the value of a "kshana" will also be large. Hence divisible, which goes against the definition given by Maharishi Vyasa. Therefore, it becomes necessary to find the value of a "kshana," which is very small, and an indivisible unit of time.

4. Possible Ultimate Indivisible Value of a Kshana

Again, from Equation (16), we can write that

$$n = \frac{8R_a R_\infty c}{\alpha R_s} = \frac{8R_\infty c}{\alpha^2} \text{kshana/sec} \tag{18}$$

where, fine structure constant $\alpha = R_s/R_a$. The ratio of the radius of the sphere (assuming that the electron is a sphere of radius R_s) to the radius of the orbit is equal to the fine structure constant [11]. All the terms on the right-hand side of Equation (18) are constants; hence, the number of kshanas "n" in a second is also constant. Substituting the values of constants R_∞, c, and α, we have $n = 263.1873566 \times 10^{14}/53.2513543849 \times 10^{-6} = 4.94235986370 \times 10^{20}$ kshanas.

Again, from Equation (17) and the value of "n" from Equation (18), which is $4.94235986370 \times 10^{20}$ kshanas, the spinning electron radius R_s will be equal to $3.86159266 \times 10^{-13}$ m, which is also the reduced Compton wavelength [5] [10] [11]. Thus, it is clear that once the exact, ultimate, indivisible value of kshana is known, one can figure out the structure of the electron. From Equation (18), it appears that $1/n = \alpha^2/8R_\infty c$ *i.e.*, 1 kshana = $2.02332494691 \times 10^{-21}$ sec, may be the ultimate value for a kshana, as defined by Maharishi Vyasa, and this needs further verification by researchers.

5. Validation of Kshana

5.1. Radius, Value of a Kshana in Sec and Mass of a Spinning Electron in Pair Production

In pair production, electromagnetic energy is converted into matter. A gamma ray of sufficient energy creates an electron-positron pair each with a mass equal to the electron mass. If E is the energy of the gamma ray that interacts by pair production, then $E = 2m_0c^2$, where m_0 is the rest mass of the positron or electron and c is the velocity of light. The rest mass energy of the electron or positron is 0.511 MeV so that there is a threshold of 1.022 MeV for this process to take place [12] [13].

The threshold frequency of the gamma ray that undergoes pair production is $\nu = E/h = 1.022$ MeV/h and which is $\nu = 2.4711850260 \times 10^{20}$ Hz.

In the paper, it is assumed that gamma radiation (electromagnetic wave) is present in electrons and positrons [6], as shown in **Figure 2**. As said in the introduction section, the time period (an attribute) of spinning electron or positron (effect) is the same as that of photon (cause), we can calculate the number of wave units (frequency) in an electron by dividing the rest energy of the electron with Planck constant. Therefore, $\nu_1 = 0.511$ MeV/h $= 1.2355925130 \times 10^{20}$

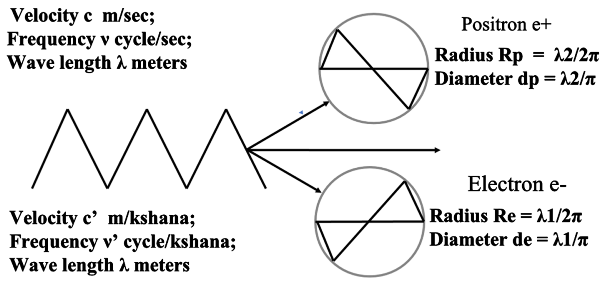

Figure 2. Gamma radiation splits into two equal frequencies with wavelengths equal to $\lambda_1 = \lambda_2$.

wave units [14], which is also equal to $\nu_1 = \nu/2 = 2.4711850260 \times 10^{20}/2 = 1.2355925130 \times 10^{20}$ Hz.

Thus, the frequency associated with electron or positron will be $\nu_1 = 1.235592513 \times 10^{20}$ Hz or cycles/sec, and wavelength will be $\lambda_1 = 2.42631 \times 10^{-12}$ meters.

5.1.1. Radius of a Spinning Electron in a Pair Production

Thus, from Equation (5)

$$c' = \lambda_1 \nu_1' = \frac{\pi R_s}{2} \text{meter/kshana} \tag{19}$$

where ν' cycles/kshana is the frequency of gamma radiation, and R_s meters is the radius of the spinning electron or positron. $T_1' = 1/\nu'$ kshanas is the time period of gamma radiation , which is also equal to the period of the spinning electron. The attributes of gamma rays are assumed to be present in electrons or positrons based on the thoughts of Maharishi Kanada [6].

$$c' = \frac{\lambda_1}{T_1'} = \frac{\pi R_s}{2} \text{meter/kshana} \tag{20}$$

However, from the definition of kshana, the period of spinning electron is T'= 4 kshanas. Therefore

$$\frac{\lambda_1}{4} = \frac{\pi R_s}{2} \text{meter/kshana} \tag{21}$$

Thus,

$$R_s = \frac{\lambda_1}{2\pi} \text{meter} \tag{22}$$

Substituting the value of λ_1, we obtain the radius of the spinning electron as $R_s = 3.8615926758 \times 10^{-13}$ meters. The radius R_s can also be found by the law of conservation of energy in the pair production, which is $h\nu_1 = m_0c^2 = 0.51$ MeV [13]. Thus,

$$h\nu_1 = \frac{hc}{\lambda_1} = 0.51\,\text{MeV} \tag{23}$$

$$\frac{hc}{2\pi R_s} = 0.51\,\text{MeV} \tag{24}$$

From Equation (22) substituting the value of λ_1 and the values of other constants in Equation (24), we have

$$R_s = \Lambda'_C = 3.86915646858 \times 10^{-13} \text{ meter} \tag{25}$$

The spinning electron radius (R_s) calculated in Equations (22) and (25) are exactly equal to the reduced Compton wavelength Λ'_C = 3.8615926796 (12) × 10^{-13} m [10].

5.1.2. Value of a Second in Kshanas

Substituting the value of electron radius from Equation (25) in Equation (9), we have

$$n = \frac{1.90853806367 \times 10^{8}}{3.86915646858 \times 10^{-13}} \text{kshana} \tag{26}$$

Thus, we have n = 4.942359860 × 10^{20} kshanas and 1 kshana = 2.0233249466 × 10^{-21} sec.

5.1.3. Determination of Planck Constant in Time Unit Kshana

The Planck constant h = 6.626070040 × 10^{-34} J·sec is converted to a value that has a time unit of kshana instead of sec. Dividing the Planck constant by "n", the new value of h will be

$$h' = \frac{h}{n} = \frac{6.62607004081 \times 10^{-34}}{4.942359860 \times 10^{20}} \text{J} \cdot \text{kshana} \tag{27}$$

Thus, the Planck constant h' = 1.34066928117 × 10^{-54} J. Kshana.

5.1.4. Determination Velocity of Light and Orbital Velocity of Electron in the First Orbit of Hydrogen Atom in Meters/Kshana

From Equation (5), we have the velocity of light c' = π3.8615926758 × 10^{-13}/2 = 6.0657755907 × 10^{-13} meters/kshana. Alternatively, we can find the velocity of light $c' = c/n$ = 2.99792458 × 10^{8}/4.942359860 × 10^{20} = 6.0657755908 × 10^{-13} meters/kshana.

5.1.5. Determination of Absolute Permittivity of the Medium When the Time Unit Is Kshana

In the SI system, the absolute permittivity of the medium is ϵ_0 = 8.854187817 × 10^{-12} coul^2/nt·m^2. The unit of ϵ_0 can be written as coul^2·sec^2/kg·m^3. The value of ϵ_0 then when the time unit is kshana is ε'_0 = 8.854187817 × 10^{-12} × (4.942359860 × 10^{20})^2 = 2.16280546198 × 10^{30} coul^2/kg·m^3·kshana^{-2}.

5.1.6. Mass of a Spinning Electron in Pair Production

By the law of conservation of energy, the mass of the electron can be found as shown below.

$$h'\nu' = m_0 c'^2 \tag{28}$$

where h', ν' and c' are the Planck constant, gamma ray frequency and velocity of light, respectively, in which the time unit is kshana. Substituting $c' = \lambda_1 \nu'$ meters/kshana in the above equation, we have

$$h' = m_0 \lambda_1^2 \nu_1' \tag{29}$$

$$h' = \frac{m_0 \lambda_1^2}{T_s'} \tag{30}$$

where $T_s' = 1/\nu'$ is the spinning period of the electron, which is 4 kshana. Thus

$$h' = \frac{m_0 \lambda_1^2}{4} \tag{31}$$

Rearranging the terms in the Equation (31), we have

$$m_0 = \frac{4h'}{\lambda_1^2} \tag{32}$$

Substituting the values of $h' = 1.340669 \times 10^{-54}$ joule. kshana (Equation (27)) and $\lambda_1 = 2.42631 \times 10^{-12}$ meters, we have a mass of the electron $m_0 = 0.91093834243469 \times 10^{-30}$ kg $= 9.1093834243469 \times 10^{-31}$ kg, which is the same as the reported CODATA value ($m_e = 9.10938356 \times 10^{-31}$ kg) [10]. The rest mass of the electron can also be found by the law of conservation of energy when the time unit is kshana, as shown below.

$$m_0 c'^2 = \frac{0.51}{n^2}\text{MeV} \tag{33}$$

where n is the number of kshanas in a second. Substituting $c' = \pi R_s/2$, and $n = 1.90853806367 \times 10^8/R_s$ in the above equation, we have

$$\frac{m_0 \pi^2 R_s^2}{4} = \frac{0.51 R_s^2}{\left(1.90853806367 \times 10^8\right)^2} \tag{34}$$

$$m_0 = \frac{4 \times 0.51 \times 10^6 \times 1.60217662208 \times 10^{-19}}{\pi^2 \left(1.90853806367 \times 10^8\right)^2}\text{kg} \tag{35}$$

$$m_0 = 9.0915757 \times 10^{-31}\,\text{kg} \tag{36}$$

The calculated mass of an electron from Equation (32), which originates from wavelength λ_1 of gamma radiation is the same as the electron mass $m_e = 9.10938356 \times 10^{-31}$ kg as reported in CODATA [10] and it shows that the time required in pair production is about four kshanas *i.e.*, equal to the spinning period of an electron. In a kshana electron mass formation is $h'/\lambda_1^2 = 0.22773458 \times 10^{-31}$ kg and in four kshanas it is equal to the reported value of electron mass (Equation (32)) [10]. It shows that the physical change in the matter *i.e.*, electron/positron production is associated with the kshana or moment and its succession. Thus, one can know the end of its succession only at the end of the physical change [1] [2].

The generation of electron and positron is due to the electromagnetic radiation or photon. The electromagnetic wave does not disappear but gets transformed into electron and positron [15]. It relates to mass of the electron and wavelength of the gamma radiation. This is like the concept of electromagnetic origin of mass particle. Erik Haeffner (2000) proposed a concept called Condensed Electromagnetic Radiation (CER) as the electromagnetic origin of mass particles. Erik Haeffner says, "The new concept CER (Condensed Electromagnetic Radiation), proposed in this article, indicates an electromagnetic origin of mass particles, in fact, an overwhelming amount of experimental evidence confirms that the CER concept is fundamental for the physical explanation of mass particle properties [14]."

5.1.7. Relating the Number of Kshanas in a Second to Absolute Permittivity and Permeability of the Medium

Velocity of light in meter/second is

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \tag{37}$$

Rewriting the above equation when the velocity of light and absolute permittivity has the time unit kshana

$$c' = \frac{1}{\sqrt{\mu_0 \varepsilon_0'}} \tag{38}$$

However, by the definition of kshana, the velocity of light $c' = \pi R_s/2$ m/kshana and $\varepsilon_0' = \varepsilon_0 \times n^2$. Therefore, from Equation (38), we have

$$n = \frac{2c}{\pi R_s} \tag{39}$$

The Equation (39) is the same as the Equation (6) or Equation (8).

5.1.8. Photo-Electric Effect and Number of Kshanas in a Second

When the incident photon energy is such that it only liberates an electron from the metal surface without any kinetic energy (*i.e.*, $mv^2/2 = 0$). In such case $h\nu_0 = W_\phi$. where ν_0 is the threshold frequency in cycles per second and W_ϕ is the work function in joule. Now rewriting the equation for the work function having time unit kshana, we have

$$h'\nu_0' = h'\frac{c'}{\lambda_0'} = w_\phi' \tag{40}$$

For $h' = h/n$, $W_\phi' = W_\phi / n^2$, and $\lambda_0 = \lambda_0' = c'/\nu_0'$ meters, we have

$$n = \frac{\lambda_0' w_\phi}{hc'} \tag{41}$$

$$n = \frac{2\lambda_0' w_\phi}{h\pi R_s} \quad \text{since} \quad c' = \frac{\pi R_s}{2} \tag{42}$$

For a tungsten cathode of threshold wavelength $\lambda_0' = \lambda_0 = 2300 \times 10^{-10}$ m, and work function $W_\phi = 5.38$ eV [16], we have

$$n = \frac{1.9085380 \times 10^8}{R_s} \text{kshana/sec} \tag{43}$$

The above equation is same as Equation (9).

Alternatively, from Equation (40), we can find the value of n as shown below:

$$h' = \frac{w_\phi}{n^2 \nu_0'} = \frac{w_\phi}{n^2 \nu_0 / n} = \frac{w_\phi}{n\nu_0} \tag{44}$$

Since $W'_{\phi} = W_{\phi}/n^2$, $\nu'_0 = \nu_0/n$, where n is the number of kshanas in one second. From Equation (31), $h' = m_0\lambda_1^2/4$. Therefore,

$$\frac{w_{\phi}}{n\nu_0} = \frac{m_0\lambda_1^2}{4} \tag{45}$$

$$n = \frac{4w_{\phi}}{m_0\lambda_1^2\nu_0} = \frac{4w_{\phi}\lambda_0}{m_0\lambda_1^2 c} \tag{46}$$

1) For a tungsten cathode with a threshold wavelength λ_0 = 2300 × 10^{-10} m, work function W_{ϕ} = 5.38 eV [16], and electron wavelength λ_1 = 2.42631 × 10^{-12} (Section 5.1), From Equation (46), the value of n will be

$$n = 4.932626423359\times10^{20} \text{ kshana} \tag{47}$$

2) For Aluminum work function is 4.25 eV [16]. The threshold frequency will be

$$\nu_0 = 1.0276454364795\times10^{15}\,\text{Hz} \tag{48}$$

and threshold wavelength $\lambda_0 = c/\nu_0$ = 2.91727523 × 10^{-7} m. Thus, from Equation (46)

$$n = 4.94236082\times10^{20} \text{ kshana} \tag{49}$$

3) For Rb, the work function is 2.16 eV [16]. Then, the threshold frequency will be ν_0 = 0.5222856806 × 10^{15} Hz, and the threshold wavelength will be λ_0 = c/ν = 5.740009 × 10^{-7} m. Thus,

$$n = \frac{4w_{\phi}}{m_0\lambda_1^2\nu_0} \tag{50}$$

$$n = 4.9423608678\times10^{20} \text{ kshana} \tag{51}$$

4) For Mg, the work function is 3.66 eV [16], and the threshold frequency will be ν = 0.88498407 × 10^{15} Hz.

$$n = \frac{4w_{\phi}}{m_0\lambda_1^2\nu_0} \tag{52}$$

where, λ_1 = 2.42631 × 10^{-12} meters.

$$n = 4.94236089\times10^{20} \text{ kshana} \tag{53}$$

5.1.9. Spectral Series of Hydrogen Atom and Kshana

The number of kshanas in a second can also be found by taking the ionization energy of the hydrogen atom, which is 13.6 eV. This is the energy needed to free the electron from the nucleus of the hydrogen atom. In the Lyman series for n = 1, the associated wavelength is 1026 × 10^{-10} meters, and the energy difference is −3.4 − (−13.6) = 10.2 eV [9]. Now we can estimate the value of n as shown below. By the law of conservation of energy, we have

$$h'\nu_0 = \frac{10.2\times1.6021766208\times10^{-19}}{n^2} \tag{54}$$

$$\frac{h'\nu_0}{n} = \frac{10.2\times1.6021766208\times10^{-19}}{n^2} \tag{55}$$

where $\nu_0 = n\nu_0' = c/\lambda_0$ and λ_0 = 1026 × 10^{-10} meters is the wavelength of the first member of the Lyman series. Thus,

$$h' = \frac{10.2 \times 1.6021766208 \times 10^{-19}}{n\nu_0} \quad (56)$$

$$h' = \frac{10.2 \times 1.6021766208 \times 10^{-19} \lambda_0}{nc} \quad (57)$$

$$h' = \frac{6628.6247 \times 10^{-37}}{n} = \frac{m_0 \lambda_1^2}{4} \quad (58)$$

$$n = \frac{4 \times 6628.6247 \times 10^{-37}}{m_0 \lambda_1^2} \quad (59)$$

Substituting the values of electron rest mass m_0 and λ_1, we get

$$n = 4.944266452 \times 10^{20} \text{ kshana} \quad (60)$$

Equations (26), (47), (48), (49), (51), (53), and (60) show that the number of kshanas in a second is the same, *i.e.*, n = 4.942359860 × 10^{20} kshanas and 1 kshana = 2.0233249466 × 10^{-21} sec.

5.1.10. Validation of Kshana or Moment with Statistical Concept of Movement of Electron

The statistical concept of movement of electron can be considered for validation of kshana. For a free spinning electron with effective Lande'-g factor g^* = 2, the radius R_s of spinning electron is [8]

$$R_s = \frac{5g^*\hbar}{4m_0 c} = \frac{5g^*\hbar}{8\pi m_0 c} \quad (61)$$

where Planck constant h = 6.626070040 × 10^{-34}; J·s, rest mass of free electron m_0 = 9.10938356 × 10^{-31} kg, and velocity of light c = 2.99792458 × 10^8 m/s. Substituting these values, we get

$$R_s = 9.6539816887 \times 10^{-13} \text{ meter} \quad (62)$$

Converting Equation (61) for radius with time unit kshana, we get

$$R_s = \frac{5g^* h'}{8\pi m_0 c'} \quad (63)$$

where Planck constant h' = 1.34066928117 × 10^{-54} J. kshana, rest mass of free electron m_0 = 9.10938356 × 10^{-31} kg, and velocity of light c = 6.0657755908 × 10^{-13} meters/kshana. Substituting these values, we get

$$R_s = 9.653981690 \times 10^{-13} \text{ meter} \quad (64)$$

Equations (62) and (64) give the same result even though time units of Planck constant h and velocity light c are different.

Spinning period for free electron is (Ziya Saglam *et al.* [8])

$$T_s = \frac{8\pi R_s^2 m_0}{5g^*\hbar} = 2.023324947 \times 10^{-20} \text{ sec} \quad (65)$$

Rewriting the Equation (65) in which $\hbar$ is replaced with $nh'/2\pi$. Since $\hbar = h/2\pi$ and $h = nh'$ where n is the number of kshanas in a second and h' is in J·kshana or kg·m^2/kshana. Thus, the number of kshanas in a second can be calculated using the rewritten formula for T_s

$$T_s = \frac{8\times 2\pi^2 R_s^2 m_0}{5g^* nh'} \tag{66}$$

$$n = \frac{16\pi^2 R_s^2 m_0}{5g^* h' T_s}\ \text{kshanas/sec} \tag{67}$$

For effective g-factor $g^* = 2$,

$$n = 4.9423598634677\times 10^{20}\ \text{kshanas/sec} \tag{68}$$

Thus, the value of "n" in Equation (68) is same as in Equations (26), (47), (48), (49), (51), (53), (60) and show that the number of kshanas in a second is the same, *i.e.*, $n = 4.942359860 \times 10^{20}$ kshanas and 1 kshana = $2.0233249466 \times 10^{-21}$ sec.

Alternatively, the ultimate indivisible value of the kshana which is 2.02332494691 $\times 10^{-21}$ sec is in good agreement with Ziya Saglam *et al.* [8]. Ziya Saglam *et al.* calculated the spinning period for a free electron which is 1.9×10^{-20} sec (for effective Lande'-g factor, $g^* = 2$). When this value of period is divided by 4 kshanas (since spinning period of free electron is 4 kshanas) give the value of 1 kshana equal to 4.75×10^{-21} sec for free electron. Both the values are of the same order of magnitude *i.e.*, 10^{-21} sec. Ziya Saglam also calculated the period of spin in an atomic state which is $T_{s\,(n=1,\,l=0,\,mj=0,\,ms=1/2)} = 1.48 \times 10^{-21}$ sec (for effective Lande'-g factor, $g^* = 1$). Again, this value of period is divided by 4 kshanas give the value of 1 kshana equal to 0.37×10^{-21} sec for period of spin in an atomic state which also has same order of magnitude *i.e.*, 10^{-21} sec.

The value of a kshana can also be determined using the circular frequency of a spinning electron given by Olszewski [17], which is $2\pi/T_2 = m_e c^2/\hbar = 0.78 \times 10^{21}$ sec^{-1} [17]. Where, period $T_2 = 2\pi/0.78 \times 10^{21}$ sec^{-1} = $8.055365778 \times 10^{-21}$ sec and a kshana is $T_2/4 = 8.055365778 \times 10^{-21}$ sec/4 = $2.0138414446 \times 10^{-21}$ sec. Again, it is same as shown in the above sections of this paper.

5.1.11. Compton Effect and a Kshana

In a Compton scattering, the Compton wavelength $\lambda_C = h(1 - \cos\theta)/m_0 c = h/m_0 c$, whose value is $2.4263102367 \times 10^{-12}$ meters [10] for $\theta = \pi/2$, where h the plank constant, m_0 is the mass of electron, c is the velocity of light and θ is the angle of scattering. Now, the Compton frequency $\nu_C = c/\lambda_C = 2.99792458 \times 10^8/2.4263102367 \times 10^{-12} = 1.2355899 \times 10^{20}$ Hz (or $\nu_C = \omega_0/2\pi = mc^2/2\pi\hbar$ [18]), and period will be $T_C = 1/\nu_C = 0.80932997877 \times 10^{-20}$ sec. Therefore, 1 kshana = $T_C/4 = 0.80932997877 \times 10^{-20}/4 = 0.20233249 \times 10^{-20}$ sec *i.e.*, $2.0233249 \times 10^{-21}$ sec and $n = 4.942359859269 \times 10^{20}$ kshanas, which is same as given in the above sections.

Again, it shows that the value of "n" is same as in Equations (26), (47), (48), (49), (51), (53), (60) and show that the number of kshanas in a second is the same, *i.e.*, $n = 4.942359860 \times 10^{20}$ kshanas and 1 kshana = $2.0233249466 \times 10^{-21}$ sec.

5.2. Determination of Reduced Compton Wavelength, Fine Structure Constant, Rydberg Constant, Spin Magnetic Moment and Spin Angular Moment

5.2.1. Determination of Compton Wavelength

The Compton wavelength is given by the equation $\lambda_C = h/m_0c$ whose value is $2.4263102367 \times 10^{-12}$ m. The reduced Compton wavelength is $\Lambda_C = \lambda_C/2\pi = h/2\pi m_0 c$ which is equal to $3.8615926764(18) \times 10^{-13}$ m [10]. Writing the reduced Compton wavelength equation where the time unit is kshana is as shown below

$$\Lambda_C = \frac{\lambda_C}{2\pi} = \frac{h'}{2\pi m_0 c'} \text{meter} \tag{69}$$

Substituting the Planck constant $h' = 1.34066928117 \times 10^{-54}$ J. kshana, the velocity of light $c' = 6.0657755908 \times 10^{-13}$ meters/kshana, and mass of the electron $m_0 = 9.10938356 \times 10^{-31}$ kg, we obtain a reduced Compton wavelength equal to $3.8615926760 \times 10^{-13}$ m which is the same as the reported CODATA value.

5.2.2. Determination of Fine Structure Constant

The orbital velocity in the first orbit of the hydrogen atom is $v' = 2.18769126277 \times 10^6/4.942359860 \times 10^{20} = 4.426410307 \times 10^{-15}$ meters/kshana. Fine structure constant is given by the following equation

$$\alpha = \frac{v'}{c'} = \frac{4.426410307 \times 10^{-15}}{6.0657755908 \times 10^{-13}} \tag{70}$$

or

$$\alpha = 0.7297352565620 \times 10^{-2} = \frac{1}{137.0359991528} \tag{71}$$

Thus, the fine structure constant is the same as that reported [10].

5.2.3. Determination of Rydberg Constant

Using the following equation [9], the Rydberg constant R_∞ is found as shown below.

$$R_\infty = \frac{m_0 e^4}{8\varepsilon_0^2 h'^3 c'} \tag{72}$$

$$R_\infty = \frac{60.0247762251 \times 10^{-107}}{546.9856635635 \times 10^{-115}} \Big/ \text{m} \tag{73}$$

The value of the Rydberg constant R_∞ is equal to 10973738.4768/meter. This agrees with the reported value R_∞ = 10973731.568525(73)/m [10].

5.2.4. Determination of Spin Angular Momentum

The spin angular momentum J is given by the following Equation [7], where the time unit is in seconds.

$$J = \frac{m_0 R_s^2 w}{2} = \frac{m_0 R_s^2 w'}{2} \tag{74}$$

where ω is rad/sec and $\omega' = \pi/2$ rad/kshana are the angular frequencies. From equation $c' = \pi R_s/2$ m/kshana [2], we can write the above equation as

$$J' = \frac{m_0 R_s c'}{2} \tag{75}$$

In semi-classical model of spinning electrons, it is assumed that [7].

$$R_s = \Lambda_c = \frac{\hbar}{m_0 c} = \frac{h}{2\pi m_0 c} = \frac{h'}{2\pi m_0 c'} \text{meter} \tag{76}$$

Substituting the value of R_s from Equation (76) in Equation (75) we have

$$J' = \frac{h'}{4\pi} = \frac{1.3406690 \times 10^{-54}}{4\pi} \tag{77}$$

$$J' = 0.106687049 \times 10^{-54} \tag{78}$$

Converting time unit kshana to time unit sec, we have

$$J = 0.106687049 \times 10^{-54} \times 4.942359860 \times 10^{20} \tag{79}$$

Thus, spin angular momentum is equal to $J = 0.527285789548 \times 10^{-34}$ which is in good agreement with the value provided by CODATA [10].

5.2.5. Determination of Spin Magnetic Moment

The spin magnetic moment of a simple model of spinning electrons [7], is

$$\mu' = IS = \left(\frac{e}{T_s'}\right)\left(\pi R_s^2\right) = \left(\frac{e}{4}\right)\left(\pi R_s^2\right) \tag{80}$$

where current $I = e/T_s'$ and e is the electronic charge. For a simple model of the spin magnetic moment $S = \pi R_s^2$ [7], $T_s' = 4$ kshanas is the spinning period of the electron. From Equation (80)

$$\mu' = \left(\frac{e}{4}\right)\left(\pi R_s \frac{h'}{2\pi m_0 c'}\right) \tag{81}$$

$$\mu' = \left(\frac{R_s}{4c'}\frac{eh'}{2\pi m_0}\right) \tag{82}$$

From Equation (11) keeping the value of c', we have

$$\mu' = \left(\frac{eh'}{4\pi m_0}\right) = 0.018764331838931 \times 10^{-42} \tag{83}$$

where h' has the unit, Joule·kshana. When it is converted to the time unit sec, we have a Bohr magneton value of $0.092740080 \times 10^{-22} = 9.27400 \times 10^{-24}$ J·T^{-1} which is equal to the reported value of Bohr magneton $\mu_B = 927.4009994(57) \times 10^{-26}$ J·T^{-1}.

6. Discussion

The focus of discussion in the paper is definition of kshana or moment and its physical significance. Equation (18) shows that the number of kshanas n in a second is a constant. Since the right-hand side of the Equation (18) has constants such as Rydberg constant, velocity of light and fine structure constant. The ultimate indivisible value of the kshana is $2.02332494691 \times 10^{-21}$ sec which is in good agreement with Ziya Saglam [8]. Thus, Maharishi Vyasa's time unit "kshana" is very small and indivisible quanta of time which needs further attention.

Equation (17) shows that the number of kshanas in a second are inversely proportional to the radius of spinning electron. Smaller the radius of spinning electron larger the value of number of kshanas in a second. **Table 1** shows the variation in number of kshanas with different values of radius of spinning electron.

This radius of the electron is found based on Maharishi Vyasa's definition of kshana [1] [2]. I obtained a reduced Compton wavelength equal to 3.8615926760 $\times 10^{-13}$ m which is the same as the reported CODATA value [10]. Apart from Compton radius, I found the number of kshanas taking classical electron radius ($2.8179403227 \times 10^{-15}$ [10]) into account which is shown in the **Table 1**.

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 of the electron. The radius of the spinning electron determined based on this definition is the same as the reported value which is equal to the reduced Compton wavelength. However, according to the calculations the value of the electron radius is large compared with the classical electron radius (**Table 1**) [10] and hence needs further attention.

According to Maharishi Vyasa's definition, one "kshana" (exceedingly small quanta of time) is equal to the time taken by the electron to traverse $\pi/2$ radians. Obviously, it appears that it can be subdivided into time intervals needed to traverse smaller angles. However, this goes against the definition of "kshana" as propounded by Maharishi Vyasa and may have some physical significance which needs further investigation. Thus, "kshana" cannot be subdivided by dividing the angle $\pi/2$.

Table 1. Comparison of number of "kshanas" in a sec for various values of radius of the electron.

Radius of an electron in meters	Value of a kshana in sec	Value of a sec in kshanas
Classical electron radius $2.8179403227 \times 10^{-15}$ m [10]	$1.476491549 \times 10^{-23}$ sec	$0.677281221 \times 10^{23}$ kshanas
Electron charge radius 0.0118×10^{-15} m [19]	$6.18274281 \times 10^{-26}$ sec	$1.617405138 \times 10^{25}$ kshanas
Hardon electron radius 10^{-18} m [20]	$5.239612554 \times 10^{-27}$ sec	$1.90853806 \times 10^{26}$ kshanas
Graviton radius 1.369×10^{-76} m [21]	$0.71730295 \times 10^{-84}$ kshanas	$1.394111076 \times 10^{84}$ kshanas

7. Conclusion

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. The radius of spinning electron determined based on Maharishi Vyasa's definition is the same as the reported value which is equal to the reduced Compton wavelength.

Acknowledgements

I am very grateful to Prof. V. S. Suryan, retired principal of C. B. College Bhalki, Dist. Bidar, Karnataka, India for incorporating English language emendations in this article. I am also grateful to Prof. Suresh Chandra Mehrotra, Dr. Babasaheb Ambedkar Marathwada University, Maharastra, India, Prof. Balachandra G. Hegade, Prof. and Chairman Rani Channamma University, Karnataka, India, and Prof. B. M. Mehtre, IDRBT, Hyderabad, India, for their feedback.

Conflicts of Interest

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

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