Simplified Method to Calculate the Radius of Particles

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ABSTRACT

The recent measurement of the proton's radius, experience carried out at Paul Scherrer Institute (PSI) in Villigen, Switzerland, by an international team of 32 researchers, showed that its radius is equal to 8.4184 x 10^{-16} meters, 4% less than 8.768 x 10^{-16} meters obtained by QED (Quantum Electrodynamics Theory). This fact brought back again the discussion about the evaluation criteria of particles' radius. In this article, based on the equilibrium model of particle interaction with the surrounding universe study through the gravitational escape potential of particles, we propose new methodology to calculate the radius of particles and we verify that theory through Quantum Mechanics.

(Keywords: particles, energy, potential, relativity, escape, quantum mechanics)

INTRODUCTION

When we think, in the radius of a particle we must think of the equilibrium model of particle interaction with the surrounding universe.

PARTICLE

The particle has a reality in three-dimensional space, and as such, we have to take into account its volume, its mass, and its "elastic" nature, represented by an "elasticity modulus" (K_e). In order to maintaining its cohesion, the particle has necessarily tendency to contract, if not it would dissolve in the universe.

The reaction from the particle will be a function, f_p of K_e, m, and V.

$$f_p\ (K_e,\ m,\ V)$$

Where:
K_e - Tensile modulus of mass.
m – Mass of the particle
V – Volume of the particle

THE SURROUNDING UNIVERSE

For the surrounding universe, we have to take into account the universal density of vacuum energy (potential energy) at local, which permeates the space and interacts with the particle through its surface.

The action from the universe on the particle is a function,

$$f_u\ (A,\ \rho_u)$$

Where:
A – The particle surface area.
ρ_u – Universal density of vacuum energy (potential energy)

THE GRAVITATIONAL ESCAPE POTENTIAL OF THE PARTICLES

The gravitational escape potential of the particle, shows how the particle interacts with the surrounding universe, allowing characterize this equilibrium.

$$U_e = \frac{2\,G\,m}{r} \qquad \textbf{(1.1)}$$

Where:
U_e – The gravitational escape potential of the particle.
G – The universal gravitational constant.
r – Radius of the particle

GENERAL CASE

Any gravitational escape potential is always a part of bigger universal gravitational escape potential C^2. The part depends on the characteristics of the particle.

φ - Factor of proportionality dependent of the characteristics of the particle.
C- Velocity of light.

$$U_e = \varphi\, C^2 \qquad \textbf{(2.1)}$$

$$\frac{2\,G\,m}{r} = \varphi\, C^2 \qquad \textbf{(3.1)}$$

$$\frac{m}{\varphi\, r} = \rho_u \qquad \textbf{(4.1)}$$

For black-hole particle, we have:

m_0- Mass of the black-hole particle.
r_0 - Radius of the black-hole particle.

$$\frac{2\,G\,m_0}{r_0} = C^2 \qquad \textbf{(5.1)}$$

$$\frac{m_0}{r_0} = \rho_u \qquad \textbf{(6.1)}$$

$$\varphi = 1 \qquad \textbf{(7.1)}$$

THE PARTICLE'S BALANCE WITH THE SURROUNDING UNIVERSE

As we proposed, we search the characteristics of the particle (K_e, V, and m) due to the reaction of the particle in response to the action that the universe surrounding exerts on it, (A and ρ_u).

To obtain the volume (V) in first member we need multiply both members of Equation (4.1) by (4 /3π r^4), we have:

$$\left(\frac{4}{3}\pi\, r^4\right)\frac{m}{\varphi\, r} = \rho_u \left(\frac{4}{3}\pi\, r^4\right) \qquad \textbf{(8.1)}$$

$$\frac{1}{\varphi} m\left(\frac{4}{3}\,\pi\, r^3\right) = (4\,\pi\, r^2)\,\rho_u\, \frac{1}{3}\, r^2 \qquad \textbf{(9.1)}$$

$$\frac{3}{\varphi\, r^2} m\left(\frac{4}{3}\,\pi\, r^3\right) = (4\,\pi\, r^2)\,\rho_u \qquad \textbf{(10.1)}$$

As:

$$4\,\pi\, r^2 = A \qquad \textbf{(11.1)}$$

$$\frac{4}{3}\,\pi\, r^3 = V \qquad \textbf{(12.1)}$$

$$\frac{3}{(\varphi\, r^2)} = K_e \qquad \textbf{(13.1)}$$

Now, we have the balance between the particle and the surrounding universe, giving its volume.

$$K_e\, m\, V = A\, \rho_u \qquad \textbf{(14.1)}$$

The balance sought.

PARTICULAR CASE OF BLACK-HOLE PARTICLE. THE VALUE OF K_e

The particular case to be considered is the black-hole particle.

From Equation (7.1) and Equation (13.1):

$$K_e = \frac{3}{(1\, {r_0}^2)} \qquad \textbf{(15.1)}$$

For Equation (13.1) to come true, K_e must be constant for all possible cases, because it's a mass elastic modulus.

$$\frac{3}{(\varphi\, r^2)} = \frac{3}{({r_0}^2)} \qquad \textbf{(16.1)}$$

$$\varphi = \frac{{r_0}^2}{r^2} \qquad \textbf{(17.1)}$$

$$K_e = \frac{3}{\left(\frac{{r_0}^2}{r^2}\, r^2\right)} \qquad \textbf{(18.1)}$$

$$K_e = \frac{3}{{r_0}^2} \qquad \textbf{(19.1)}$$

THE EQUILIBRIUM MODEL OF THE PARTICLE INTERACTION WITH THE SURROUNDING UNIVERSE

Now we have characterized all the factors involved in the interaction model of the particle with the surrounding universe.

Now, we know one of the ways, as the universal density of vacuum energy (potential energy) that permeates the space, interacts with the mass of the particles, shaping its volume.

$$K_e\, m\, V = A\, \rho_u \qquad \textbf{(20.1)}$$

$$V = \frac{A\,\rho_u}{K_e\,m} \quad \textbf{(21.1)}$$

The total universal density of vacuum energy (potential energy) in place on the particle surface exerts traction on its surface and in its inner surface, have a reaction of equal value but opposite way, caused by the potential elastic energy of mass, proportional to its mass, its elastic modulus, and its volume.

THE RADIUS OF THE PARTICLES

After characterizing the equilibrium model of particles with the surrounding universe, we are able to calculate its radius from its mass. From Equation (4.1), we have:

$$m\,r = \rho_u\,\varphi\,r^2 \quad \textbf{(22.1)}$$

From Equation (17.1), we have:

$$m\,r = \rho_u\,\left(\frac{r_0{}^2}{r^2}\;r^2\right) \quad \textbf{(23.1)}$$

$$m\,r = \rho_u\,r_0{}^2 \quad \textbf{(24.1)}$$

$$r = \frac{\rho_u\,r_0{}^2}{m} \quad \textbf{(25.1)}$$

THE NEW ASPECT OF GRAVITATIONAL ESCAPE POTENTIAL OF THE PARTICLES

The gravitational escape potential is always a part of the greater universal gravitational escape potential C^2. From Equation (2.1), we have:

$$U_e = \frac{r_0{}^2}{r^2}\;C^2 \quad \textbf{(26.1)}$$

THE PRIMORDIAL RADIUS OF MASS, r_o

Using this new information, it is possible to measure directly the radius of the proton we can calculate the primordial radius r_o of mass:

r_{proton}= 8.4184 x 10^(-16)m

m_{proton}= 1.67262178 x 10^(-27)Kg

From Equation (25.1) and taking into account the proton mass and radius:

$$r_o{}^2 = \frac{m\,r}{\rho_u} \quad \textbf{(27.1)}$$

$$r_o = \sqrt{\frac{m\,r}{\rho_u}} \quad \textbf{(28.1)}$$

$$r_o = 4.57294357 \text{ x } 10^{-35}\,\text{m} \quad \textbf{(29.1)}$$

This is the value of the primordial radius of the mass.

THE TENSILE MODULUS OF POTENTIAL ENERGY OF MASS

$$K_e = \frac{3}{r_o{}^2}$$

$$K_e = 1.43459585 \text{ x}10^{69}\ \text{m}^{-2} \quad \textbf{(30.1)}$$

The simplified modulus, K_e:

$$k_s = \frac{1}{r_o{}^2} \quad \textbf{(31.1)}$$

$$k_s = 4.78198617\text{x}10^{68}\ \text{m}^{-2} \quad \textbf{(32.1)}$$

IN GENERAL TERMS, WE HAVE:

From Equation (25.1):

$$m\,r = \rho_u r_o{}^2 \quad \textbf{(33.1)}$$

To our actual referential, how ρ_u and $r_o{}^2$ are constants and considering:

$$\rho_u r_o{}^2 = k' \quad \textbf{(34.1)}$$

From Equation (25.1):

$$m\,r = k' \quad \textbf{(35.1)}$$

$$m\,r = 1.40807992 \text{ x}10^{-42} \quad \textbf{(36.1)}$$

In all particles de product of its mass by its radius is always constant.

$$m\,r = m_o r_o \quad \textbf{(37.1)}$$

Otherwise

ρ_u– Density of potential energy generated by the particle on its surface. ($\frac{m}{r}$)

$$\frac{m}{\frac{r_0^2}{r^2}\,r} = \rho_u \qquad \textbf{(38.1)}$$

$$\frac{m}{r}\,\frac{r^2}{r_0^2} = \rho_u \qquad \textbf{(39.1)}$$

$$\rho_p\,\frac{r^2}{r_0^2} = \rho_u \qquad \textbf{(40.1)}$$

$$2\,G\,\rho_p\,\frac{r^2}{r_0^2} = C^2 \qquad \textbf{(41.1)}$$

The gravitational escape potential of particle:

$$2\,G\,\rho_p = \frac{r_0^2}{r^2}C^2 \qquad \textbf{(42.1)}$$

The universal density of vacuum energy (potential energy) on the particle surface is equal to the density of potential energy generated by the particle itself in its surface, multiplied by the number of times that the particle's surface increased, in relation to the particle's primordial surface ($\frac{r^2}{r_o^2}$).

If we consider that the particle are not under to the universal density of vacuum energy (potential energy) generated by all universal masses, and the particle are only under the density of potential energy generated by itself on it surface, we have:

$$\rho_u = \frac{m}{r} \qquad \textbf{(43.1)}$$

$$\frac{m\,r}{r_0^2} = \frac{m}{r} \qquad \textbf{(44.1)}$$

$$r^2 = r_o^2 \qquad \textbf{(45.1)}$$

$$r = r_o \qquad \textbf{(46.1)}$$

At the time of the Big-Bang if all universal mass was contained in a single particle, then the radius of the Big-Bang would r_o.

WHAT IS THE GREATEST VISIBLE MASS POSSIBLE FOR A PARTICLE?

As we saw before, we know what the radius of the particle depends on its mass. The highest possible mass for a visible particle will be at the edge of becoming a black-hole.

From Equation (25.1):

$$m_o = \frac{\rho_u r_o^2}{r_o} \qquad \textbf{(47.1)}$$

$$m_o = \rho_u r_o \qquad \textbf{(48.1)}$$

$$m_o = 3.07915437\text{x}10^{-8}\ \text{Kg} \qquad \textbf{(49.1)}$$

THE VERIFICATION FROM QUANTUM PHYSICS

When we think, in the radius of a particle we must think of the equilibrium model of particle interaction with the surrounding universe.
Trough QM we can characterize this equilibrium, from the equilibrium between the particle energy and its matter wave frequency

As:.
h – Planck constant
√ - Frequency of mass energy
λ- Wavelength of the particle energy

$$m\,C^2 = h\ \sqrt{} \qquad \textbf{(1.2)}$$

$$m\,C^2 = h\,\frac{C}{\lambda} \qquad \textbf{(2.2)}$$

$$h = m\,\lambda\,C \qquad \textbf{(3.2)}$$

Already the calculation of the Planck mass was used the proportionality between the radius particle and the wavelength of the particle energy and we agree with this proportionality.

γ - Factor of proportionality

$$\lambda = \gamma\,r \qquad \textbf{(4.2)}$$

The Planck's constant is given by:

$$h = \gamma\,m\,r\,C \qquad \textbf{(5.2)}$$

$$m\,r = \frac{h}{\gamma\,C}(\text{a constant}) \qquad \textbf{(6.2)}$$

$$r = \frac{h}{\gamma\,m\,C} \qquad \textbf{(7.2)}$$

For a black hole, we have:

$$h = \gamma\,m_0\,r_0\,C \qquad \textbf{(8.2)}$$

$$m_0\,r_0 = \frac{h}{\gamma\,C} \qquad \textbf{(9.2)}$$

From Equations (6.2) and (7.2), we have:

$$m\,r = m_0\,r_0 \quad \textbf{(10.2)}$$

$$m\,r = \frac{m_0}{r_0}\,r_0 r_0 \quad \textbf{(11.2)}$$

$$m\,r = \frac{m_0}{r_0}\,\rho_u\,{r_0}^2 \quad \textbf{(12.2)}$$

$$r = \frac{\rho_u}{m}\,{r_0}^2 \quad \textbf{(13.2)}$$

We conclude that the proposed theory is verified by QM and itself is capable to resolve the problem.

THE VALUE OF Y

Taking into account the proton mass and radius, we can develop numerically, the present theory. Then, where, h is Planck's constant.

$$\gamma = \frac{h}{m\,r\,C} \quad \textbf{(14.2)}$$

$$\gamma = 1.569668647 \approx \frac{\pi}{2} \quad \textbf{(15.2)}$$

CONCLUSION

Now if the new theory proposed is verified by QM, we have two methods for calculation of the radius of the particles

.
From the new theory:

$$r = \frac{\rho_u\,{r_0}^2}{m} \quad \textbf{(16.2)}$$

From QM:

$$r = \frac{h}{\gamma\,m\,C} \quad \textbf{(17.2)}$$

From Equations (16.2) and (17.2), we have:

$${r_0}^2 = \frac{2\,G\,h}{\gamma\,C^3} \quad \textbf{(18.2)}$$

REMINDER

Through this article, we saw how the universal density of potential energy interferes with the size of all particles, as it interferes with its mass. We believe that this analysis will be important to the future development of physics.

GENERALIZING FOR ALL COMMON PARTICLES

The calculation of the particle's radius from its mass or energy can be applied to all common particles.

Table 1: Common Particles' Radii as a Function of their Mass and their Energy.

Particle	Mass (Kg)	Energy (eV)	Radius (m)
Neutron	$1.6749\text{x}10^{-27}$	939565379	$8.406812\text{x}10^{-16}$
Proton	$1.6726\text{x}10^{-27}$	938272047	$8.41840\text{x}10^{-16}$
Electron	$9.1094\text{x}10^{-31}$	510999	$1.54575\text{x}10^{-12}$

VALUES FOR GENERAL PARTICLES RADIUS

The calculation of the particles' radii from its mass or energy can be applied to all particles.

Table 2: Table 2: General Particle Radius, as a Function of their Mass and their Frequency. E=10^.

Frequency of the particle	Mass of particles (Kg)	Radius of the particle (m)
1,0000E+14	7,37E-37	1,90991E-06
1,0000E+15	7,37E-36	1,90991E-07
1,0000E+16	7,37E-35	1,90991E-08
1,0000E+17	7,37E-34	1,90991E-09
1,0000E+18	7,37E-33	1,90991E-10
1,0000E+19	7,37E-32	1,90991E-11
1,0000E+20	7,37E-31	1,90991E-12
1,0000E+21	7,37E-30	1,90991E-13
1,0000E+22	7,37E-29	1,90991E-14
1,0000E+23	7,37E-28	1,90991E-15
1,0000E+24	7,37E-27	1,90991E-16
1,0000E+25	7,37E-26	1,90991E-17
1,0000E+26	7,37E-25	1,90991E-18
1,0000E+27	7,37E-24	1,90991E-19
1,0000E+28	7,37E-23	1,90991E-20
1,0000E+29	7,37E-22	1,90991E-21
1,0000E+30	7,37E-21	1,90991E-22

VALUES ADOPT:

h = 6.62606957(29) x10^{-34} $Kg^1 . m^2 .s^{-1}$
C = 299 792 458 m/s
G = 6.67384(80) x10^{-11} $m^3 .Kg^{-1} . s^{-2}$

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