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Quantum Gravity Balance Radius

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ABSTRACT: In normal stars, the radius is large because thermal pressure pushes stellar shells outward. As stars collapse into white dwarfs, neutron stars, and black holes, the quantum forces pack particles as tightly as possible. When a black hole forms, general relativity says the singularity shrinks to a point with zero radius, and its density is infinite. However, quantum gravity changes this by setting a minimum value of a physical dimension called the Planck length or Quantum Gravity Balance Radius. Heisenberg's quantum pressure equilibrium with gravitational pressure or Quantum energy equilibrium with gravitational compression energy yields the Quantum gravity balance Radius R. The system balances at a minimum radius, preventing a true zero-size point. Confined systems stay stable when inward gravity is equal to outward pressure. In stars, an outward pressure comes from hot gas and radiation. White Dwarfs Pressure comes from electron degeneracy since electrons refuse to occupy the same state according to the Pauli exclusion principle. In the Neutron Stars, Pressure comes from neutron degeneracy. At the core of black holes, standard pressure fails to save the singularity. Quantum gravity introduces an ultra-high Planck pressure or Quantum gravity pressure balance effect that is involved in keeping the singularity ball from collapsing and annihilating to a zero point. This quantum pressure acts as the ultimate repulsive force to stop the singularity from collapsing further, and keeps the singularity as compacted sphere approximately the size of atoms with huge density, pressure, temperature, angular momentum, and gravity. Quantum gravity balance plays a crucial role in calculating the radius, length, wavelength, quantum pressure, quantum energy, vibration velocity, frequency, Photon energy, and surface temperature of particles in a confined system, typically the particles in the black hole singularity. The visible universe was a Planck singularity that formed inside a Parent Supergiant black hole, escaped into space, and evaporated as the superparticles to form photon particles, Quarks, subatomic particles, atoms, stars, celestial objects, and galaxies in the visible universe since cooled extremely. An origin of multiverses is initiated as escaped superparticles or a quantum singularity from a supergiant black hole of this type.

KEYWORDS: Heisenberg Uncertainty Principle; Quantum Localization Energy; Gravitational Compression Energy; Quantum Gravity Pressure Balance; Quantum Gravity Balance Radius **R**; Planck Singularity; Parent Supergiant Black Hole.

1. INTRODUCTION

In traditional general relativity, a black hole ends in a point of infinite density called a singularity. However, applying quantum corrections suggests that this collapse either stops and explodes outward in a "Big Bounce," creating an expanding universe, or is suspended due to a quantum-gravity pressure balance and repulsion [1, 2, 3]. The idea of a "Parent Supergiant Black Hole" that birthed the visible universe and the multiverse belongs to the realm of theoretical speculation rather than mainstream astrophysics in the present time [4]. It typically stems from Black Hole Cosmology (or Schwarzschild cosmology). The black hole has the capacity to tear mass from its companion stars and celestial objects to grow rapidly. The supermassive black hole, with a mass of millions to billions of times the mass of the Sun, can be a resident at the heart of massive galaxies [5, 6, 7, 8, 9, 10]. The black hole can grow to the mass of the visible universe when entire cosmic monsters merge to form a cosmic mass black hole. In standard physics, the Schwarzschild radius is the boundary (event horizon) where a black hole's mass becomes so dense that gravity traps light. Interestingly, if you calculate the Schwarzschild radius for the estimated mass of the observable universe (roughly $\mathbf{10^{53}}$ kg), it perfectly matches the radius of galaxy clusters or our observable universe. The concept that the mass of a parent supergiant black hole could be trillions of times larger than the visible universe is a hallmark of hierarchical, or "fractal," multiverse models (such as the Black Hole Universe model). Scientists thought these theories offered elegant mathematical solutions to the mystery of a Big Bang; however, they are highly speculative because the interior of an event horizon is inherently unobservable to us. These models are highly speculative and cannot currently be tested. The quantum gravity theory is still one of the best scientific theories has developed to describe quantum fluctuation in the interior shells of a black hole. The parent supergiant black hole could be available in a distant location from the visible universe and multiverse; as a result, it is difficult to be detected by our humble technology at the present time.

Indeed, the Planck singularity could be formed from a huge amount of mass and energy that is comparable to the mass and energy of a visible universe and as small as an atom.

The Planck singularity was formed inside a parent supergiant black hole when a huge amount of dust and gas particles were dropped from an accretion disc of a parent supergiant black hole and concentrated in its interior shells to reach the Planck density and form a Planck singularity ball in the size of an atom or an atomic nuclei. Quantum gravity is an elegant theory that is able to describe the interior shells of a black hole and phenomenon occur in the deepest points of a black hole, white dwarfs, and neutron stars. However, quantum gravity is still a scientific theory, but its result is incredibly essential to enhance our understanding of the formation and evolution of the visible universe, multiverses, and black holes. Also, it is necessary to help us understand phenomena that occur in the deepest points of a black hole's interior structures, typically in the structure of a quantum singularity sphere or Planck singularity. The concept that the universe resides within an unimaginably massive black hole is a fascinating theoretical framework in cosmology. However, the specific parameter "Quantum Gravity Balance Radius" is not a formally defined or standard metric in mainstream physics. While some theoretical models, such as Black Hole Universe scenarios, explore the idea of our universe emerging from a collapse or bounce, they do not universally claim that a parent black hole outweighs the universe by trillions of times. Within these cosmic hypotheses, the "Heisenberg Balance Radius" defines the ultimate threshold where the outward quantum pressure (from vacuum fluctuations, string interactions, or spacetime torsion) perfectly balances the inward pull of gravity. Vacuum fluctuations are the temporary, random changes in energy in space, described in quantum field theory (QFT) by the energy-time Heisenberg Uncertainty Principle. Because a system's energy cannot be strictly zero for an infinitesimally short duration, space is actually a dynamic sea of probabilities buzzing with zero-point energy [11, 12]. It resolves the famous "information paradox" and the "singularity" problem by ensuring no infinite point of density is ever reached. Instead, the black hole's interior behaves as a closed, expanding cosmos. The mass of a singularity sphere in the heart of a parent supergiant black hole may reach trillions of times the mass of the visible universe, and its density exceeds the Planck density, but its size remains as the size of an atom due to its enormous spinning speed, angular momentum, gravity, and frame dragging of the spacetime fabric. The Heisenberg's quantum gravity balance radius of a black hole singularity in the heart of a parent supergiant black hole remains as an atomic radius. Its gravitational tunnel waves in the spacetime fabric are high enough to drag enough amount of mass from its surroundings to feed itself and grow or form new cosmic seeds, cosmic singularities, and release them into a cosmic void far away from a parent black hole and form there new universes, comparable to the visible universe in mass and laws.

The main objectives of this study are to derive and calculate the Quantum Gravity Balance Radius R, Quantum gravity pressure balance, Quantum energy, vibration velocity, Photon energy, and surface temperature of particles in a confined system.

2. HEISENBERG UNCERTAINTY PRINCIPLE

The Heisenberg Uncertainty Principle is a foundational rule in quantum mechanics stating that we cannot simultaneously know a particle's precise position and its exact momentum (speed and direction), that is a solid summary of the concept [13, 14, 15]. It highlights the fundamental "trade-off" that exists at the quantum level. It's not a limitation of our measuring tools, but a basic property of the Universe itself. The product of the uncertainty in the position, radius, length, distance, and wavelength of a particle ($\Delta \boldsymbol{x} = \boldsymbol{R} = \boldsymbol{L} = \boldsymbol{d} = \boldsymbol{\lambda}$) and the uncertainty in its momentum ($\Delta \boldsymbol{p} = \boldsymbol{mv}$), can never be less than one-half of the reduced Planck constant $\hbar$:

$$\Delta \boldsymbol{x}.\Delta \boldsymbol{p} \geq \frac{\hbar}{2} \qquad \textbf{(1)}$$

If we know everything about where a particle is located or have determined its optimum position (the uncertainty of position is small), we know nothing about its momentum and speed (the uncertainty of momentum is large), and vice versa. Versions of the uncertainty principle also exist for other quantities, such as energy and time. We discuss the momentum-position and energy-time uncertainty principles of the particles in any regime separately. The product of the uncertainty in the energy of a particle ($\Delta \boldsymbol{E}$) and the uncertainty in its time $\Delta \boldsymbol{t}$ can never be less than one-half of the reduced Planck constant $\hbar$:

$$\Delta \boldsymbol{E}.\Delta \boldsymbol{t} \geq \frac{\hbar}{2} \qquad \textbf{(2)}$$

The energy-time uncertainty principle states that the more precisely the energy of a quantum system is known, the less precisely its lifetime can be determined, and vice versa. In practical terms, it implies that unstable states or particles that exist for a very short duration will have a naturally "fuzzy" or spread-out energy. This is why short-lived particles in physics have an inherent decay width, as there isn't enough time to measure their energy frequency with absolute precision in an excited atom. The relationship between time and frequency is fundamental to wave mechanics. A wave describes a quantum state, and to define its frequency, and therefore energy, via ($\boldsymbol{E} = \boldsymbol{hf}$) precisely, you must observe it over a long period. A short-lived state is a "pulse" or a wave packet. Representing a brief pulse requires superimposing many different frequencies. A state that lasts a long time is nearly a continuous wave with a very specific single frequency. A short-lived state has a broad spread of frequencies, meaning it has a large energy uncertainty. The reduced Planck constant, $\hbar$ or (h-bar), is defined as the Planck constant ($\boldsymbol{h}$) divided by $\boldsymbol{2\pi}$, then the exact value for a reduced Planck constant approximately ($\hbar = \frac{h}{2\pi} = \frac{6.626 \, x \, 10^{-34} J.s}{2\pi} = \boldsymbol{1.05457 \, x \, 10^{-34} J.s}$).

3. QUANTUM LOCALIZATION ENERGY

For a particle with mass **m** confined to a region of size or radius ($\Delta x = R$), the uncertainty principle for position and momentum of particle gives:

$$\Delta p = mv = \frac{\hbar}{2R} \quad (3)$$

Thus, the characteristic kinetic quantum energy is:

$$E_q = \frac{(\Delta p)^2}{2m} \quad (4)$$

Substitute equation. (3) into the equation.(4) yield to:

$$E_q = \frac{(\Delta p)^2}{2m} = \frac{(\frac{\hbar}{2R})^2}{2m} = \frac{\hbar^2}{4R^2}\, x \,\frac{1}{2m} = \frac{\hbar^2}{8mR^2}$$

$$E_q = \frac{\hbar^2}{8mR^2} \quad (5)$$

This acts as an effective quantum energy E_q resisting against gravitational compression energy.

4. GRAVITATIONAL COMPRESSION ENERGY

Gravitational compression energy is the thermal or structural energy released when mass is pulled inward by its own gravity, thereby reducing its volume and increasing its density. In astrophysics models, this conversion of gravitational potential energy into heat and pressure drives the formation of stars and planets and even powers core-collapse supernovae [16, 17, 18, 19, 20]. Assume matter density ρ and mass enclosed within radius R for spherical objects is:

$$M = \rho V = \rho \, \frac{4}{3}\pi R^3 \quad (6)$$

Self-gravitational potential energy scales as:

$$E_g = \frac{G\,M^2}{R} \quad (7)$$

Substituting the value of **M** in the equation. (6) into the equation. (7) to get:

$$E_g = \frac{G\,(\rho V)^2}{R} = \frac{G\,(\rho\frac{4}{3}\pi\,R^3\,)^2}{R} = G\,(\,\rho\,\frac{4}{3}\pi R^3\,)^2\, x \,\frac{1}{R} = G\rho^2\,\frac{16}{9}\pi^2 R^6\, x\,\frac{1}{R} = G\rho^2\,\frac{16}{9}\pi^2 R^5.$$

$$E_g = \frac{16}{9}\pi^2 G\rho^2 R^5 \quad (8)$$

5. QUANTUM GRAVITY ENERGY BALANCE RADIUS

Equilibrium occurs when the quantum localization energy E_q in the equation. (5) balances gravitational compression energy E_g at eqn. (8) to determine the Heisenberg quantum gravity balance radius **R**:

($E_q = E_g$), hence $\left(\frac{\hbar^2}{8mR^2} = \frac{16}{9}\pi^2 G\rho^2\, R^5\,\right)$, Multiply both sides by R^2 yielding:

$\left(\frac{9\,\hbar^2}{8m\,G\rho^2\,16\,\pi^2} = R^7\,\right)$, rearrange these balance relations $\left(\frac{9\,\hbar^2}{128\,\pi^2\;Gm\rho^2} = R^7\,\right)$, to solve for **R**, take the $(1/7)$ power of both sides.

$$R = \left(\frac{9\,\hbar^2}{128\,\pi^2\;Gm\rho^2}\right)^{1/7} \quad (9)$$

Restated an equation. (9) In terms of constants, this is approximately:

$$R = 0.493\,\left(\frac{\hbar^2}{Gm\rho^2}\right)^{1/7} \quad (10)$$

This radius **R** is the characteristic minimum confinement scale at which Quantum uncertainty pressure (also known as quantum dispersion, Heisenberg uncertainty pressure, or vacuum fluctuation pressure) and gravitational self-attraction (specifically Newtonian self-gravity or the Schwarzschild radius) are balanced, representing the point where quantum-mechanical spreading is counteracted by gravitational collapse. This scaling resembles: degeneracy-pressure equilibrium, boson-star core radii, quantum gravity cores, fuzzy dark matter localization scales, pre-singularity regularization models, and modified TOV equilibrium systems. It effectively defines a quantum-gravitational localization radius below which Heisenberg pressure prevents further compression.

This interpretation accurately summarizes the key physical principles governing the stability of a particle (like a boson or fermion) within a self-gravitating system, often referred to as boson stars or the Heisenberg-Pauli limit for degenerate systems. Here is a breakdown of **points:** Larger mass (M) of a System, has a stronger confinement: larger total system mass (M) produces a stronger gravitational potential, pulling the particle wave function inward. Smaller particle mass (m) (Constituent), larger quantum support scale: This is the Heisenberg uncertainty principle in action. For a lighter particle with a smaller mass m, the momentum uncertainty results in a higher kinetic energy and quantum pressure for a given confinement size. A lower mass (m) means the wave function is more spread out, leading to a larger "support scale." This sets a minimum stable radius before collapse: Stability is achieved when the gravitational contraction balances the quantum pressure. If the system is compressed below a critical radius or if the system mass (M) becomes too large, the quantum pressure cannot keep up with gravity, leading to collapse into a black hole. The gravitational potential energy E_g is relative, meaning the height (**h=R**) is measured from a chosen reference point, typically the ground or a table surface. When an object falls, its gravitational potential energy **GPE** is converted into kinetic energy **KE**.

$$E_g = mg\,h = \frac{GM\,m}{R} \quad (11)$$

6. QUANTUM AND GRAVITY PRESSURE BALANCE RADIUS

Gravitational force is a fundamental, attractive interaction that draws any two objects with mass or energy toward each other. It depends on the mass of objects and the distance between them. It acts at a distance with an infinite range or much narrower distances, pulling objects together based on their mass and proximity, governing the structure of the universe from falling stones, dust particles, apples, to orbiting stars, planets, and galaxies.

$$F = mg = \frac{GMm}{R^2} \quad (12)$$

This formula calculates the attraction force **F** between two objects with masses (M, m) separated by distance (d=**R=h**), where **G** is the gravitational constant, **g** is the gravitational acceleration of the falling objects. Acceleration due to gravity on Earth's surface is ($g = 9.81\frac{m}{s^2}$). At average or extreme densities, Quantum Gravity equilibrium occurs because the Heisenberg quantum pressure $\boldsymbol{P_q}$ equals the gravitational pressure $\boldsymbol{P_g}$.

$$P_q = \frac{\hbar^2}{8\,mR^5} \quad (13)$$

$$P_g = \frac{GM^2}{R^4} \quad (14)$$

Substituting the value of Mass ($\boldsymbol{M = \rho V = \rho\,\frac{4}{3}\pi R^3}$) in the equation. (6) into the equation. (14) to get:

$$P_g = \frac{GM^2}{R^4} = \frac{G\,(\rho\,\frac{4}{3}\pi R^3)^2}{R^4} = \frac{G\,(\rho^2\,\frac{16}{9}\pi^2 R^6)}{R^4} = G\rho^2\,\frac{16}{9}\pi^2 R^2$$

$$P_g = \frac{16}{9}\pi^2 G\rho^2 R^2 \quad (15)$$

The Heisenberg quantum pressure equilibrium with gravitational pressure ($\boldsymbol{P_q = P_g}$) yields the Quantum gravity balance radius R:

$$\left(\frac{\hbar^2}{8\,mR^5} = \frac{16}{9}\pi^2 G\rho^2 R^2\right)$$

$$R = \left(\frac{9\,\hbar^2}{128\,\pi^2\,Gm\rho^2}\right)^{1/7} \quad (16)$$

$$\left(\frac{9\hbar^2}{128\,\pi^2\,Gm\rho^2} = R^7\right)$$

Extract the 7th root of both sides to isolate **R** completely. This provides the final expression for the balance radius:

$$R = \sqrt[7]{\frac{9\,\hbar^2}{128\,\pi^2\,Gm\rho^2}} \quad (17)$$

This equation typically arises in the study of self-gravitating quantum systems, such as boson stars, Black holes, singularity, Planck density, or simplified models of degenerate stars. It represents the equilibrium point where the repulsive "pressure" from the uncertainty principle (represented by the $\hbar$ term) balances the inward pull of gravity (represented by the G and $\boldsymbol{\rho}$ terms).

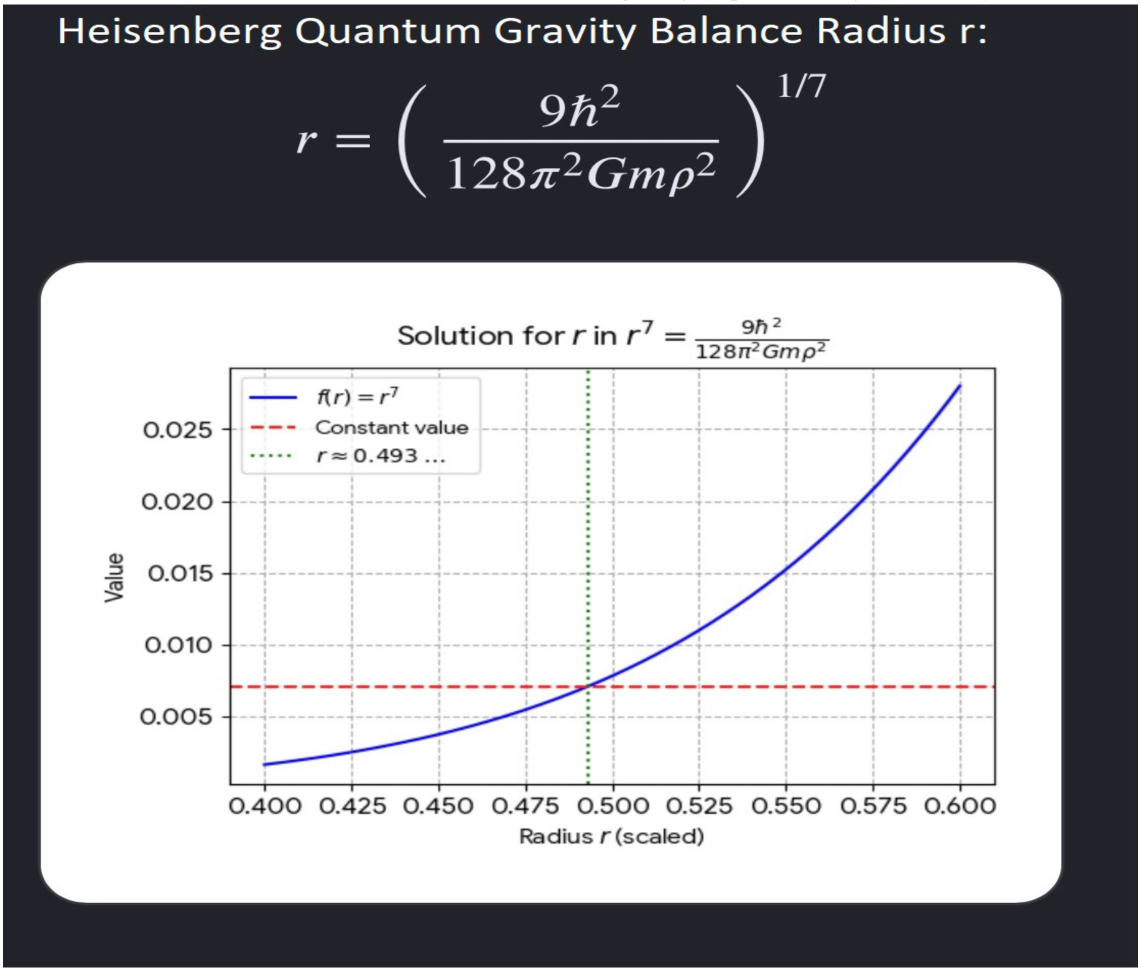

Fig. 1. Quantum Gravity Balance Radius R.

Problem 1: Find the quantum gravity balance radius **R** for a Particle with a mass of the Planck mass ($m = m_{Planck} = 2.17643\,x10^{-8}kg$) inside the Solar mass star ($1.98\,x10^{30}kg$) with an average density ($\rho = 1408\,Kg/m^3$), a white dwarf star, Neutron star, black dwarf, a Solar mass singularity, and Planck density ?.

Solution: At the **First Step**, I need to calculate the quantum gravity balance radius **R** for a Particle similar to a

Planck mass inside a solar mass star with an average density ($\rho = 1408\ Kg/\boldsymbol{m^3}$), insert values in an equation (**9**) below:

$$\boldsymbol{R} = \left(\frac{9\,\hbar^2}{128\,\pi^2\ Gm\rho^2}\right)^{1/7}.$$

$$\boldsymbol{R} = \left(\frac{9\ x\ (1.0545718\ x10^{-34}\ J.s)^2}{128\ (3.14)^2\ x\ (6.6743\ x\ 10^{-11}\ \frac{N.m^2}{Kg^2})x(2.17643\ x10^{-8}\ kg)\ x(1408\ Kg/m^3)^2}\right)^{1/7}$$

To find the value of **R** for a Planck mass particle inside a solar mass star, we use the provided formula and the standard physical constants for the Sun and quantum mechanics. Then ($\boldsymbol{R = 4.31\ x\ 10^{-9}\ m = 4.31nm}$).

At the **Second Step**, I need to calculate the quantum gravity balance radius **R** for a Particle similar to a Planck mass inside a white dwarf star with a density ($\rho = 10^9\ Kg/\boldsymbol{m^3}$), insert values in an equation (**9**) to get quantum gravity balance radius is: ($\boldsymbol{R = 9.17\ x\ 10^{-11}\ m}$), which is roughly the scale of an atom (approximately 0.92 Å).

At the **Third Step**, I have to calculate the quantum gravity balance radius **R** for a Particle similar to a Planck mass inside a Neutron star with a density ($\rho = 5\ x\ 10^{17}\ Kg/\boldsymbol{m^3}$), insert values in an equation (**9**) to find the value of **R** for a Planck mass particle inside a neutron star using the provided formula, we use standard physical constants and typical neutron star properties to get: ($\boldsymbol{R = 2.999\ x\ 10^{-13}\ m = 0.2999\ picometers}$). In the **Fourth Step**, I need to calculate the quantum gravity balance radius **R** for a Particle similar to a Planck mass inside a Solar mass black hole with a density ($\rho = 1.84285\ x\ 10^{19}\ Kg/\boldsymbol{m^3}$). Insert total values in an equation (**9**) to find quantum gravity balance radius is: ($\boldsymbol{R = 1.07\ x\ 10^{-13}\ m}$), which is the radius R for a Planck mass particle inside a solar mass black hole.

In the **Fifth Step**, I have to calculate the quantum gravity balance radius **R** for a Particle similar to a Planck mass inside a Solar mass singularity with a radius of Hydrogen Atom. For a solar mass singularity compressed into Hydrogen radius 53 picometer, first compute the mean density ($\rho = \frac{M}{V} = \frac{1.98\ x\ 10^{30}\ Kg}{\frac{4}{3}\pi\ (5.3\ x\ 10^{-11}m)^3} = 3.2\ x\ 10^{60}\ Kg/\boldsymbol{m^3}$). To solve this problem, we first define the universal physical constants and the specific values provided in the prompt. Substitute values in an equation (**16**) to find quantum gravity balance radius, it is approximately: ($\boldsymbol{R = 1.7645\ x\ 10^{-25}\ m}$), which is the radius R for a Planck mass particle inside the surface of a solar mass black hole singularity which squeezed into a Bohr radius (Hydrogen atom size).

In the **Final Step**, the Heisenberg quantum gravity balance radius **R** For a Planck mass particle inside a cosmic mass singularity or Planck singularity at Planck density ($\rho = 5.155\ x\ 10^{96}\ Kg/\boldsymbol{m^3}$). Plug the constants into an equation (**9**) to find quantum gravity balance radius: ($\boldsymbol{R = 7.975\ x\ 10^{-36}\ m}$), which is roughly half (**0.498**) the magnitude of the standard Planck length($\boldsymbol{L_{Planck} = 1.6\ x\ 10^{-35}\ m}$). If $\frac{R}{\boldsymbol{L_{Planck}}} = \frac{(\boldsymbol{7.975\ x\ 10^{-36}\ m})}{(\boldsymbol{1.6\ x\ 10^{-35}\ m})} = \boldsymbol{0.498.}$ It's proven that the Heisenberg quantum gravity balance radius for a Planck Mass particle is given a correct value and approximately the value of a Planck length in a Planck density condition or inside a ball with a cosmic singularity that compressed to a Planck density [21, 22, 23]. This is an optimum result for quantum gravity physics. This particle is slightly squeezed inside a Planck density or in the lower shell of a Planck singularity. The Planck mass particle is a superparticle that is squeezed steeply inside the Planck density or in a Planck singularity. The Planck length is not a minimum length in nature. The particles with mass of subatomic particles, atoms, and molecules could be compressed into a smaller radius than a Planck length due to the suppression of a singularity sphere. Indeed, the Planck length is not the minimum length of particles or their radius. The singularity may compress Planck mass particles into the smallest length or radius at the core of a singularity ball.

7. PLANCK SINGULARITY

The Planck density is the theoretical upper limit for density in physics, calculated using Planck units. In black hole physics, it represents the extreme threshold where gravity, space, and time are quantized, preventing the infinite collapse known as a singularity in general relativity. The concept of Planck density didn't develop as a single, formal "theory" on its own; instead, it is a boundary condition and derived unit that emerged from the marriage of Max Planck's quantum theory, Einstein's general relativity, and modern cosmology. As physicists began to understand the theoretical limits of gravity and quantum mechanics, they realized that the fundamental Planck length and Planck mass could be combined to calculate the maximum theoretical limit for density. Several scientific theories emerged from the concept of the Planck scale and Planck density. The **Cosmic Singularity Limit or a Planck Singularity**: General relativity predicts that the universe originated from an infinitely dense "Big Bang" singularity. Quantum physicists use Planck density as a conceptual limit, proposing that the universe's density cannot exceed the Planck density, thus avoiding true infinities in physics. **The Singularity Barrier**: Under classical General Relativity, the matter inside a black hole collapses infinitely into a "singularity"; it is a point of zero volume and infinite density. However, this is largely considered a mathematical breakdown of the theory. Quantum mechanics suggests that nothing can be compressed beyond the Planck volume without causing spacetime to break down entirely. **Planck Stars**: In Loop Quantum Gravity (a theoretical framework), when a collapsing star reaches the Planck energy/mass density inside a black hole's event horizon, it stops collapsing. A repulsive quantum force is generated, potentially preventing the collapse before a singularity forms, resulting in an ultra-massive but microscopic core known as a Planck star. Carlo Rovelli and Francesca Vidotto theorized that as a black hole collapses, quantum-gravitational pressure halts the collapse when the matter reaches a Planckian density, resulting in a microscopic "bounce". They suggested this creates a Planck star rather than a singularity, which eventually reverses the black hole into a white hole, resolving the information paradox. In their 2014 paper, "Planck stars", physicists Carlo Rovelli and Francesca Vidotto propose that collapsing black holes do not form infinite central singularities. Instead, quantum-gravitational pressure derived from loop quantum gravity principles that causes the collapsing matter to experience a "bounce," turning the black hole into a radiating white hole [24, 25, 26]. **Quantum Evaporation Remnants**: Many theoretical physicists argue that as black holes evaporate via Hawking radiation, they will eventually shrink down to a stable, Planck-density remnant. This tiny remnant could theoretically hold all the information the black hole ever swallowed, avoiding the so-called "information paradox".

The **Planck Singularity**: is the densest and most compact object. It has been explained in the Quantum Gravity Theory. It is possible that the mass of the visible universe could be compressed into the size of an atomic nucleus to reach the Planck density and create a cosmic mass singularity or a Planck singularity. The Planck Singularity refers to the theoretical boundary of the Big Bang event, where the visible universe was formed as a surviving superparticle or a Planck singularity at the center of a cosmic parent black hole, where General Relativity, gravity and Quantum Mechanics collide. Below the Planck length and Planck time, mathematical models break down, indicating a physical limit to our understanding of the Universe. In the Planck length, Planck density, Planck Singularity, Planck time, and Big Bang event, quantum gravity theory is an optimum theory capable of describing the Big Bang Event or the moment before a Big Bang. Before and after the Big Bang Event, the multiverses and Visible Universe had been created as seeds, superparticles, and Planck singularity in the heart of a Cosmic Parent Black Hole or a Parent Supergiant Black Hole. The Visible Universe is an ultra-massive particles or Planck Singularity that was created from a collapsed enough amount of matter and energy into the heart of a Cosmic Parent Black Hole and escaped into free space with a speed higher than the speed of light, evaporated, progressed, cooled and expanded to form celestial objects, stars, particles, atoms, Planets, living creatures, Photons, and galaxies.

General Relativity predicts the matter could be collapsed to a "point of infinite density" or a singularity point in the black hole centre. The Big Bang theory is the prevailing cosmological model explaining the origin and evolution of the universe. It posits that about 13.8 billion years ago, the universe expanded rapidly from an extremely tiny, hot, dense singularity and continues to expand even today or to the future [27, 28, 29, 30]. However, when gravity operates on subatomic, quantum scales, our traditional equations yield nonsensical answers like infinite probabilities and infinite curvature. During Planck time, the universe was so unimaginably dense and hot that all four fundamental forces, including gravity, are believed to have been unified into a single quantum gravity state. Physicists generally agree that traditional "point" singularities do not literally exist in nature. Instead, the Planck scale represents a fundamental barrier where a unified theory of quantum gravity such as string theory or loop quantum gravity is required to describe this reality accurately. In quantum mechanics, variables cannot be infinitely squeezed into a zero point due to the Heisenberg Uncertainty Principle. Therefore, many modern theories suggest that space cannot shrink below the Planck length, which implies black holes and the early universe might not form true, infinitely dense singularities at zero size. Understanding the quantum mechanics of the Planck regime is essential for solving the black hole information paradox and explaining how black holes lose mass over time via Hawking Radiation. Heisenberg Quantum Gravity Scale, resulting in a visual explanation of how the concepts of infinities, quantum mechanics, gravity, and space-time boundaries. Quantum gravity balance radius **R** is a new scale comparable to the Planck length for a Planck mass particle inside the Planck density or a Planck singularity.

Problem 2: Find the density of a Cosmic mass Singularity (Planck Singularity), if the entire visible Universe has been compressed into the size of an Atomic nuclei (1.67 fm), and find the quantum gravity balance radius **R** for a Particle with a mass of the Planck mass ($m = m_{Planck} = 2.17643\, x10^{-8} kg$) inside this cosmic mass singularity ?. Calculate , Quantum gravity energy balance, and Quantum gravity pressure balance?.

In the **First** Step, I have to calculate an average density for a cosmic mass singularity that compresses into a radius of an atomic nucleus approximately 1.67 femtometers. The nuclear radius of an atom defines the physical size of its central nucleus. Because nuclei are not solid spheres with sharp boundaries, the radius of an atomic nucleus is calculated statistically by using the charge distribution. Atomic nuclei Radii typically range from 1 fm to 10 fm. Nuclear size depends directly on the number of nucleons (protons and neutrons) inside the nucleus. Then an average density of a Universe singularity is approximately equal to a Planck Density or a Planck Singularity ($\rho_{Planck} = \frac{M_U}{V_n} = \frac{1\, x\, 10^{53}\, Kg}{\frac{4}{3}\pi\, (1.67\, x\, 10^{-15}\, m)^3} = 5.128\, x\, 10^{96}\, Kg/\boldsymbol{m^3}$).

In the **second** step, Substitute values in the equation (**16**) to find quantum gravity balance radius **R**:

$$\boldsymbol{R} = \left(\frac{\boldsymbol{9\, \hbar^2}}{\boldsymbol{128\, \pi^2\;\, Gm\rho^2}}\right)^{\boldsymbol{1/_7}}.$$

$$\boldsymbol{R} = \left(\frac{\boldsymbol{9\, x}\, (1.0545718\, x10^{-34}\, \boldsymbol{J.s})^2}{\boldsymbol{128}\, \boldsymbol{(3.14)^2\, x} \left(\boldsymbol{6.6743\, x\, 10^{-11}\, \frac{N.m^2}{Kg^2}}\right) \boldsymbol{x}\, (2.17643\, x10^{-8}\, kg)\, \boldsymbol{x}\, (5.128\, x\, 10^{96}\, Kg/\boldsymbol{m^3})^2}\right)^{\boldsymbol{1/_7}}$$

The calculated value for **R** based on the provided physical constants and expression it is about: ($R = 7.988\, x\, 10^{-36}\, m$). This indicates that the Planck mass within a Planck length is a Superparticle, compressed inside a Planck Singularity, with the mass of the Universe and the size of an atomic nucleus. Planck mass particles are Planck foam and superparticles in degenerate pressure due to quantum gravity pressure balance inside the Planck Singularity.

In the **Third** step, substitute Planck mass **m**, quantum gravity balance radius **R**, and reduced Planck constant approximately $\left(\hbar = \frac{h}{2\pi} = \mathbf{1.05457\, x\, 10^{-34} J.s}\right)$, in eqn. (5) to calculate Heisenberg's quantum energy balance $(\boldsymbol{E_q})$:

$$\boldsymbol{E_q} = \frac{\hbar^2}{8mR^2} = \frac{(1.05457\, x\, 10^{-34} J.s)^2}{(\,8\, x\, 2.17643\, x 10^{-8}\, kg\, x\, (7.988\, x\, 10^{-36}\, m\,)^2} = \mathbf{1001013701.69\, J.}$$

Then, insert Gravitational constant **G**, Planck density ρ, and quantum gravity balance radius **R** in eqn. (8) to calculate a Gravitational energy balance $(\boldsymbol{E_g})$:

$$(\boldsymbol{E_g} = \frac{16}{9}\pi^2 G\rho^2 R^5\,).$$

$$[\boldsymbol{E_g} = \frac{16}{9}\pi^2 x \left(6.6743\, x\, 10^{-11}\, \frac{N.m^2}{Kg^2}\right) x \left(5.128\, x\, 10^{96} \frac{Kg}{m^3}\right)^2 x\, (7.988\, x\, 10^{-36}\, m)^5].$$

$$\boldsymbol{E_g} = \mathbf{1001013701.69\, J.}$$

Then, the Quantum Gravity Energy Balance is approximately $\left(\boldsymbol{E_q = E_g = 1001013701.69\, J}\right)$. Thus, $(\boldsymbol{E_q = E_g = 1\, x\, 10^9 J = 1GJ})$. This energy value $(\mathbf{1\, GJ})$ is approximately half of the Planck energy $(\boldsymbol{E_{Planck} = 1.956\, GJ}\,)$. The Planck energy is a fundamental unit of energy in the system of natural units. It represents the upper limit of energy in quantum mechanics and the scale at which quantum gravity becomes significant.

In the **Final** steps, substitute Planck mass **m**, quantum gravity balance radius **R**, and reduced Planck constant approximately $(\hbar = \mathbf{1.05457\, x\, 10^{-34} J.s})$, in equation (**13**) to calculate Heisenberg's quantum pressure balance $(\boldsymbol{P_q})$:

$$\boldsymbol{P_q} = \frac{\hbar^2}{8\, mR^5} = \frac{(1.05457\, x\, 10^{-34} J.s)^2}{(\,8\, x\, 2.17643\, x 10^{-8} kg\, x\, (7.988\, x\, 10^{-36}\, m\,)^5} = \mathbf{1.96\, x\, 10^{114} Pa.}$$

Then, insert Gravitational constant **G**, Planck Density ρ and quantum gravity balance radius **R** in eqn. (15) to determine a Gravitational pressure balance $(\boldsymbol{P_g})$:

$$(\boldsymbol{P_g} = \frac{16}{9}\pi^2 G\rho^2 R^2).$$

$$[\boldsymbol{P_g} = \frac{16}{9}\pi^2 x \left(6.6743\, x\, 10^{-11}\, \frac{N.m^2}{Kg^2}\right) x \left(5.128\, x\, 10^{96} \frac{Kg}{m^3}\right)^2 x\, (7.988\, x\, 10^{-36}\, m)^2\,].$$

$(\boldsymbol{P_g = 1.96\, x\, 10^{114}\, Pa})$. Then, the Quantum Gravity Pressure Balance is approximately $\left(\boldsymbol{P_q = P_g = 1.96\, x\, 10^{114}\, N/m^2}\right)$.

In the context of physics, this value represents an extremely high energy density or pressure, often discussed in theoretical models involving the Planck scale and Black hole singularity with a cosmic mass. The Planck mass remains in the Planck scale inside the Planck sphere or Planck Singularity due to huge Planck density and Planck pressure. This indicates that the visible universe and multiverse are multiple singularities and cosmic seeds were born inside the Parent Supergiant black hole and expand into the cosmic void and infinite space to form new universe contained particles, galaxies and celestial objects. Indeed, survived Planck singularity may have evaporated and expanded in space to form stars, planets, photons, atoms, and galaxies for a newborn universe. The visible universe was a Planck singularity formed from collapsed matter and energy inside the parent supergiant black hole, and escaped into free space to give birth to our visible universe. Multiple singularities with the mass of a Planck singularity capable of escaping into infinite space to form a new universe, including the multiverse as our visible universe. The birth of multiple singularities initiated from a collapsed state of matter and energy in the core of a supergiant black hole, where a tremendous type of singularity is hidden in its heart to participate in the formation and evolution of the Planck singularities. The journey of the visible universe or multiverse started in the interior shells of a black hole, where matter and energy collided, compressed, and spun up steeply to form a singularity with the mass and size of a Planck singularity. The matter and spacetime could be dragged and condensed steeply in the core and event horizon of a black hole, typically at the edge of a singularity to form new superparticles or singularity. The singularity and superparticles may grow rapidly since collecting matter and energy from its surrounding. Superparticle with mass of a mountain may grow to the mass of a universe after collecting enough amount of mass and energy.

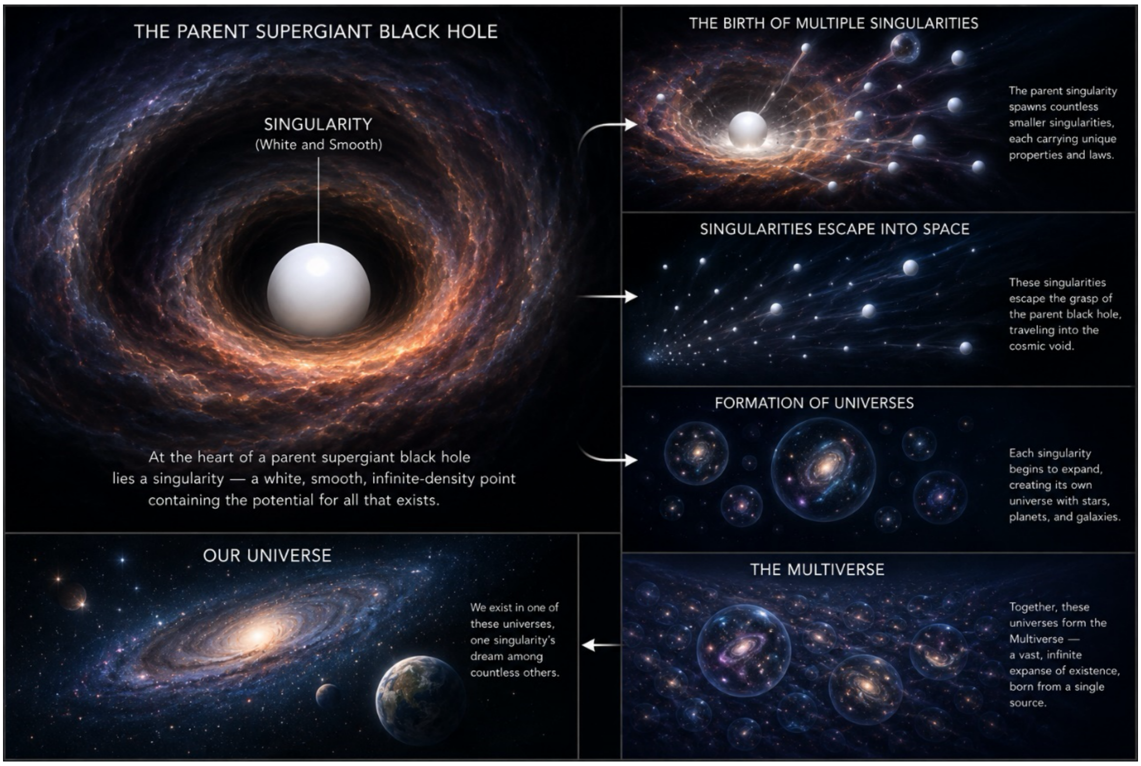

Fig. 2. Parent Singularity in the Heart of a Parent Supergiant Black Hole.

8. PARENT SUPERGIANT BLACK HOLE

The concept of a parent singularity in a Supergiant black hole lies at the intersection of general relativity, gravity, quantum mechanics, and black hole cosmology. This idea proposes that our observable universe formed inside an immense black hole before the Big Bang event, connecting cosmological origins to black hole interiors. The visible universe was a Planck singularity that had been created inside the Parent Supergiant black hole and escaped into space to form matter, energy, time, stars, galaxies, and living creatures in the visible universe after its evaporation into space. Classical general relativity predicts that the gravitational collapse ends in a singularity of infinite density. However, quantum mechanics introduces degeneracy pressure that halts infinite collapse, triggering a rapid expansion or "bounce" that birthed our cosmos or multiverse. Einstein-Cartan Gravity introduces quantum torsion to prevent matter from compressing indefinitely. Instead of a singularity, the collapsing matter reaches a finite, extremely high density and expands outward, forming a bridge between the parent universe and a child universe. The laws governing our universe, including early inflation and current accelerated expansion, could be the direct result of the energy and momentum inherited from this parent singularity in the core of a supergiant black hole and multiverse expansion. The "Quantum Bounce" Instead of Singularity where traditional equations break down, quantum principles prevent infinite density, acting as a cradle for new cosmic dimensions rather than pure destruction. A Multiverse Chain: This theory suggests an endless sequence of nesting universes, where a parent singularity spawns a visible universe and multiverses. The black holes within that newly formed universe go on to spawn others, create whole stars and galaxies. The black holes are involved in the formation and evolution of galaxies and the universe. The visible universe was a Planck singularity has been created in a violent event in the compacted and violent world at the heart of a parent supergiant black hole. Its size was very small, close to the size of an atom and proton, but its density was incredibly high, as the Planck density before Big Bang era and during a Planck time.

The idea that our observable Universe and multiverse were birthed from a parent supergiant black hole, often referred to as Black Hole Cosmology or Schwarzschild Cosmology, is an intriguing theoretical framework. It merges theories of general relativity, quantum mechanics, and the multiverse into a recursive, cosmic model. In this hypothesis, our Universe resides entirely within the event horizon of a colossal parent black hole, which exists in a larger, pre-existing space before inflation. The parent black hole feeds on matter and energy from an immense accretion disc. As matter is dragged in, intense gravitational forces, frame-dragging (the twisting of spacetime), and friction generate incredible amounts of energy. According to models proposed by physicists like Nikodem Popławski, when matter collapses inside a black hole, it does not crush into an infinite point (singularity). Instead, quantum effects and torsional forces cause the matter to "bounce," initiating a rapid, explosive expansion acting as our Big Bang [31, 32, 33, 34, 35]. Because this process happens recursively through endless feeding and collapsing across higher dimensions, every supermassive black hole might serve as a gateway to a new "baby universe," effectively generating an eternally inflating multiverse. Scientists and researchers continue to look for signatures that might hint at our origin within a parent black hole. Some astronomers note unexpected anomalies in cosmic data, such as preferred rotational alignments in distant galaxies observed by the James Webb Space Telescope, suggesting that the early Universe may have inherited a rotational axis from a parent black hole. All states of matter and energy had been compacted and accumulated steeply in the singularity state and quantum gravity pressure for a long time before the universe began to expand continuously during its journey through the dark fabric of the universe. Our visible universe evaporated, losing enough energy and mass in its journey to form new cooled state of matter and energy. The density of dark fabric matter and cosmic seed had been decreased when cosmic seed of an our universe escaped and evaporated in the cosmic void at distant places from its source of creation, which is the parent supergiant black hole. Most of the mass of a cosmic seed vanished and evaporated due to its huge speed, angular momentum, and kinetic energy in its longer journey of expansion and evolution. The visible universe is a sphere spanning roughly 93 billion light-years in diameter, containing an estimated two trillion galaxies. Beyond this lies the unobservable universe and, according to theoretical physics, potentially the multiverse, a vastly larger theoretical network of separate universes, each with its own space, time, and physical laws.

The observable universe is an ever-expanding expanse of space, roughly 46 billion light-years in radius, that continuously produces stars. Through processes like accretion and mergers, this constant star formation and recycling of matter fuels the staggering growth of supermassive black holes at the centers of galaxies. Black holes grow primarily through two physical processes: **accretion** (pulling in surrounding gas, dust, and stars) and **mergers** (colliding and combining with other black holes). This growth ultimately builds supermassive black holes at the centers of galaxies [36, 37, 38, 39, 40]. It is truly incredible to think about the scale of it all. To add a bit more detail, those supermassive black holes aren't just passive consumers; they act like cosmic engines. As they pull in all that gas and dust from star-forming regions, they release massive amounts of energy that can actually regulate how many new stars a galaxy can create, keeping the whole system in a delicate, violent, and balance. Stars are born when clouds of gas and dust collapse under gravity. As the visible universe grows and space stretches, this star-making process recycles pristine matter into heavier elements, and fuelling subsequent generations of stars. Supermassive black holes, often containing millions or billions of times the mass of our Sun, exist at the centers of nearly all large galaxies. They grow by swallowing surrounding gas and dust of an accretion disc and by colliding/merging with other black holes. Recent observations by the James Webb Space Telescope reveal that some of these early black holes actually grew at incredible rates, far exceeding traditional physics constraints to become giants in the primeval cosmos. Beyond our visible bubble of space, some cosmological theories suggest the existence of a multiverse. In theories like black hole cosmology, it is mathematically posited that the event horizon of a black hole in a parent universe might act as a "bouncing" point, spawning an entirely new expanding universe on the other side. The supermassive black holes, including those in our visible universe and multiverse, can grow vastly to become a supergiant black hole since collecting enough mass and energy from their surroundings to become a supergiant black hole and recycling the growth of our universe and the multiverse. The parent Supergiant Black Hole has the most powerful Plasma jets. Typically, display when collecting mass from its exterior edge to form superparticles or feeds its parent singularity at its core or during an escaping number of superparticles or multiple singularities with cosmic mass from the grasp of a parent supergiant black hole. Gas and dust particles are spiralling inward or escaping outward as plasma jets when any turbulence occurs in the compacted fabric or spacetime fabric of a black hole and multiverses. The plasma jets are caused to save the main balance of a black hole and the cosmic fabric. Matter pulled toward a black hole, it does not fall in all at once. Instead, it forms a spinning, superheated structure called an accretion disk. As gas and dust spiral inward, immense gravitational field and magnetic forces twist the magnetic fields, acting like a particle accelerator. These magnetic funnels shoot a fraction of this material outward in opposite directions at relativistic speeds. The electron orbits of the excited atoms are distorted and elongated in plasma liquids, lightning belts, an accretion disc, and plasma jets due to powerful electromagnetic fields and thermal pressure effects. The visible universe and multiverse could be formed from collapsed gas and dust particles in an accretion disc of a parent supergiant black hole. The multiverse can expand and grow as a visible universe to save the entire balance of a cosmic fabric or the fabric of infinite existence. We are living in the arm of an infinite world, yet we do not know more about it. The creation and expansion of a multiverse can influence the formation, evolution, and expansion of the visible universe and black holes. The plasma jets are clear evidence of the formation of a new universe and are spiralling a tremendous amount of gas and dust particles into the inner shells of a black hole. Powerful Plasma jets display at the edge of a parent supergiant black hole due to a concentrated, tremendous amount of matter and energy in its accretion disc.

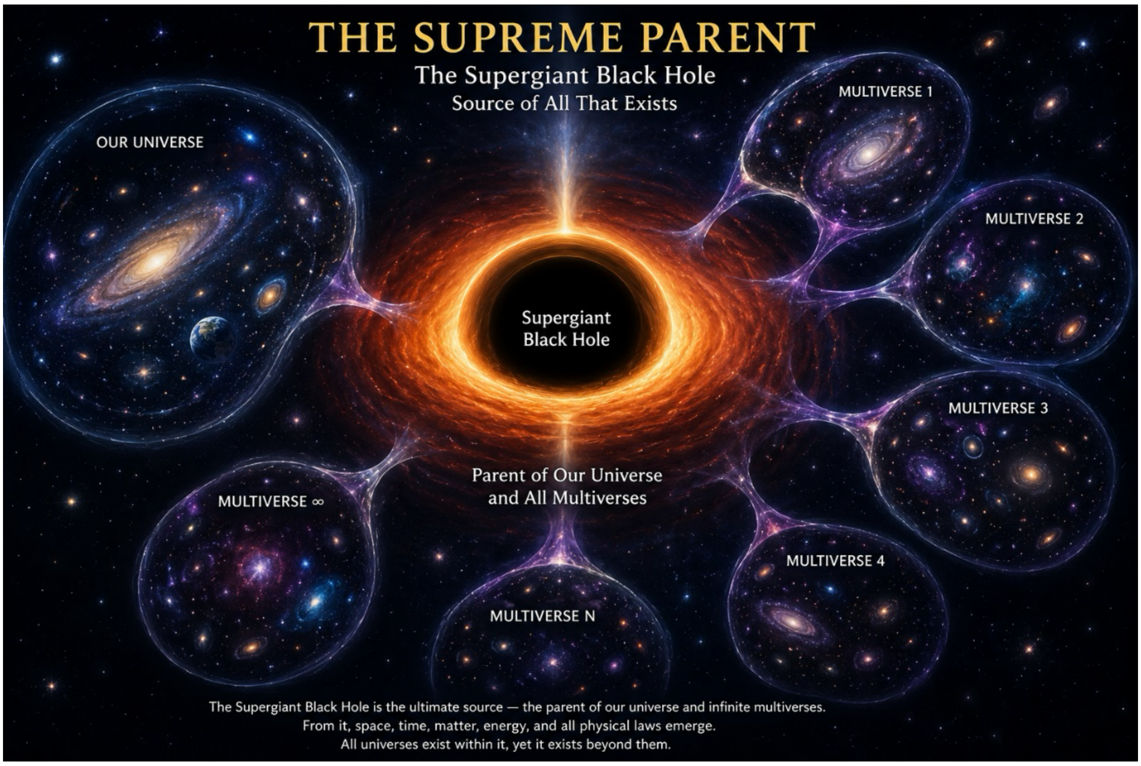

Fig. 3. Parent Supergiant Black Hole.

9. BLACK HOLE JETS

Black hole jets are powerful plasma jets caused by gas and dust particles with the mass of Mountains, Moons, Earth, stars, and galaxies spiralling into a black hole's event horizon, accelerating, colliding, and heating enormously, then escaping from its grasp. They are massive beams of bright, ionized matter and magnetic fields blasting outward at near-light speeds from the regions surrounding stellar mass black holes, supermassive black holes, such as the famous M87 or the record-breaking 23-million-light-year-long Porphyrion jets. Porphyrion is the largest supermassive black hole jet system ever discovered, spanning an astonishing equivalent to lining up 100 Milky Way galaxies end-to-end. Located in a distant location inside the universe, these gargantuan jets of hot plasma are actively spreading heat, energetic particles, and magnetic fields into intergalactic space. Unlike smaller jet systems confined to dense galaxy clusters, Porphyrion shoots outward through the sparse filaments of the "cosmic web". Scientists believe these massive outflows spread vital magnetic fields and energy throughout the universe, potentially helping to shape how galaxies form. It is named after a mythical giant from Greek mythology, known as the greatest of the Gigantes. Black hole jets are powerful streams of energized particles launched outwards from the poles of a black hole at speeds approaching the speed of light. Powered by intense magnetic fields and the swirling motion of accretion disks, they act as massive cosmic fountains, involved in shaping and evolution of galaxies and galaxy clusters, accelerating the formation of stars and planets, and enhancing the cosmic web [41, 42, 43, 44]. Jets do not escape directly from inside the event horizon; instead, they tap into the energy of the surrounding accretion system.

Astrophysicists understand that nothing, not light or particles, can escape easily from inside the event horizon of a black hole. Instead, here is how the physics of these jets actually work or how **jets formed**: At **First**, in an accretion disk, matter (like gas and dust) swirls around the black hole in a giant, hot, rotating disk. In the **second** step, the black hole, as a cosmic engine, rotates and draws in surrounding matter, and its extreme magnetic fields become twisted and coiled. **Eventually**, these twisted magnetic fields act like giant cosmic accelerators, funnelling a fraction of the swirling material and firing it outward along the black hole's poles before it ever crosses the point of no return. Gas, dust particles, and photons could be trapped and concentrated steeply at the bottom of a black hole to feed the singularity at its core. Black hole jets are colossal, narrow beams of plasma and radiation blasted into space at nearly the speed of light. They originate just outside the event horizon- not from inside the black hole- when magnetic fields channel superheated, infalling matter away from the poles of the accretion disk. Furthermore, Stellar jets are fast, narrow beams of gas and plasma that shoot out from stars. They usually shoot out in opposite directions from the top and bottom of a spinning star. Plasma jets and stellar lightning, including proton lightning jets analogous to those observed on Earth are critical to coronal heating dynamics. They emerge vertically from the photosphere and chromosphere, driving violent turbulence. Together, these phenomena propel heated plasma upwards and accelerate particles, sustaining the multi-million-degree temperature of the stellar corona. The maximum solar flare temperature could be approximately 80 million kelvins. Plasma Jets & Spicules: Relatively cool plasma is propelled upwards from the stellar surface into the outer atmosphere at supersonic speeds (e.g., up to 150 km s^{-1}). These jets interact dynamically to heat the solar corona through magnetic reconnection and shockwaves. As these jets and electrical currents travel, they enhance turbulence. This dynamic process allows magnetic energy and kinetic energy to dissipate into heat, which is a leading explanation for how stellar upper atmospheres reach temperatures significantly hotter than their visible surfaces [45, 46, 47, 48, 49, 50]. The mystery of coronal heating understanding how the Sun and stars maintain their outer atmospheric temperatures while the layers immediately below remain relatively cool has been a long-standing challenge in solar and stellar astrophysics. Solar spicules are dynamic, needle-like jets of magnetized plasma that shoot up from the Sun's surface (the photosphere) into its outer atmosphere (the chromosphere). Millions of these transient, hair-like structures erupt across the Sun's surface at any given time, lasting only a few minutes before falling back down. Solar spicules are generated by interactions between the Sun's complex magnetic field and acoustic waves. The interplay between electrically charged plasma and neutral gas particles in the lower solar atmosphere acts like a whip, launching material upward. A typical spicule is about 300 to 500 km in diameter and extends anywhere from 5,000 to 10,000 km above the solar surface. They are highly short-lived, erupting and collapsing in just 5 to 10 minutes. Solar spicules are ubiquitous, jet-like bursts of plasma that erupt from the Sun's chromosphere at speeds up to 150 km/s. They act as crucial, dynamic conduits for mass and energy, bridging the gap between the solar surface and the mysterious, superheated outer atmosphere that called the corona.

10. FREQUENCY AND SURFACE TEMPERATURE OF PARTICLES IN A CONFINED SYSTEM

In extremely compact systems such as black hole singularities, white dwarfs, and neutron stars, particle properties are governed by quantum mechanics and intense gravity. The surface temperatures, quantum states, and frequencies of particles depend on the object's mass and collapse density. The vibration frequency and surface temperature of particles in a confined system are deeply linked through the principles of thermodynamics, quantum mechanics, and statistical mechanics. Macroscopic temperature represents the average kinetic energy of the particles, which translates directly into their microscopic frequency of oscillations and collision. In a solid or bound system, an increase in surface temperature increases the thermal energy, causing the particles to vibrate faster. The relationship between temperature T and the average velocity or kinetic energy of a particle is classically defined by the Maxwell-Boltzmann Distribution. Because frequency $\boldsymbol{f}$ relates to energy via the Planck constant **h** in a Planck relationship ($E = \boldsymbol{hf}$), higher thermal energy yields higher-frequency and oscillations within the system's potential well and density. Under the framework of Einstein's General Relativity, the concept of a particle's speed inside a black hole's event horizon is highly complex. It cannot exceed the speed of light for objects with mass. The behaviour of matter and speed in this region is defined by these core principles: The **Cosmic Speed Limit**: In Special Relativity, physical objects with mass can never travel at or exceed the speed of light (c). **Spacetime Flow**: Once inside the event horizon, the curvature of space and time is so extreme that space itself falls toward the central singularity. This fabric of space flows inward faster than the speed of light, carrying all particles, their information, and objects with it regardless of their own velocity. **Collapse of Physical Models**: At the singularity itself, the theoretical point of infinite density scientists believe our current laws of physics break down entirely. Concepts of standard velocity and space cease to function normally, meaning we do not have a proven theory describing exactly how particles move at the exact point of the singularity. The **quantum-gravity theory** still an essential and successful theory to describe the dynamical phenomena of particles and measured their surface temperatures in a compact region, typically inside a Quantum singularity or Planck density [51, 52, 53, 54, 55]. The speed of superparticles inside a black hole singularity equalized with the speed of light or exceeded it widely ($\boldsymbol{v} \geq \boldsymbol{c}$). Photons in a vacuum always travel at the same constant speed of light c. Because their velocity is fixed, changes in their wavelength dictate their frequency and energy. Shorter wavelengths correspond to higher frequencies and greater energy, while longer wavelengths mean lower frequencies and less energy. Because the Planck constant **h** and the speed of light are absolute constants, a photon's characteristics are tied together by mathematical proportion: Energy and Frequency are directly proportional: As frequency goes up, the energy goes up. Energy and Wavelength are inversely proportional: As wavelength gets longer, the energy goes down. Frequency and Wavelength are inversely proportional: As wavelength gets longer, the frequency gets lower. Rearrange equation (3) to find the uncertainty scale velocity $\boldsymbol{v}$ of the particle in a confined system:

$$\boldsymbol{v} = \frac{\hbar}{2mR} \quad \textbf{(18)}$$

Then, de Broglie wavelength ($\boldsymbol{\lambda}$) is:

$$\boldsymbol{\lambda} = \frac{h}{p} = \frac{h}{mv} \quad \textbf{(19)}$$

$$\boldsymbol{f} = \frac{v}{\lambda} = \frac{v}{\lambda = C = 2\pi R} = \frac{v = c}{\lambda \cong R} \quad \textbf{(20)}$$

$$\boldsymbol{v} = \boldsymbol{R}\,\boldsymbol{w} = \boldsymbol{R}\,\boldsymbol{2\pi f} \quad \textbf{(21)}$$

$$\boldsymbol{w} = \boldsymbol{2\pi f} \quad \textbf{(22)}$$

$$\boldsymbol{E} = \boldsymbol{hf} = \hbar \boldsymbol{w} \quad \textbf{(23)}$$

$$\boldsymbol{E_{th}} = \frac{3}{2} \boldsymbol{K_B}\,\boldsymbol{T} \quad \textbf{(24)}$$

The singularity and superparticles are two compressed objects. They are compressed balls filled with a condensed state of matter and energy. The radius of particles in a confined system, or a quantum singularity due to the quantum gravity balance **Radius**, is (**R**). The particles in a confined system or Quantum singularity sphere have higher rotational speed, vibrations, and tangential velocity comparable to speed of light ($\boldsymbol{v = c = 300,000 \frac{km}{s}}$). These energetic particles and photon particles around them or on the surface of vibrating particles inside a singularity or neutron stars have narrower wavelengths approximately equal to circumference $\boldsymbol{C}$ or radius R and diameter **d** of an energetic particle ($\boldsymbol{\lambda = C = 2\pi R}$) $\boldsymbol{or}$ ($\boldsymbol{\lambda = d = 2R \cong R}$). Also these superparticles of a black hole have maximum vibration frequency $\boldsymbol{f}$, angular velocity $\boldsymbol{w}$, higher quantum energy of Photon particles $\boldsymbol{E}$, huge surface temperature T and thermal energy $\boldsymbol{E_{th}}$. At the most fundamental theoretical scale, quantum gravity describes physics at the extreme limit where gravity and quantum mechanics merge. This is governed by the Planck scale, which peaks at an upper energy bound corresponding to the Planck Temperature ($T_{Planck} = 1.41\ x\ 10^{32}K$). Photon energy ($\boldsymbol{E = hf}$) and thermal energy ($\boldsymbol{E_{th} = \frac{3}{2} K_B\, T}$) are equalized to calculate the surface temperature T of particles in the confined system, such as energetic particles inside quantum singularities, white dwarfs, neutron stars, hot celestial objects, and stars.

$$\boldsymbol{T = \frac{E=hf}{1.5\ K_B}} \qquad \textbf{(25)}$$

Where ($\boldsymbol{K_B = 1.38\ x\ 10^{-23} \frac{J}{K}}$) is the Boltzmann constant. The Boltzmann constant is an exact physical constant that relates average kinetic energy to absolute temperature. In a confined microscopic system at extremely high temperatures, particle frequencies scale with thermal energy, while surface temperatures govern heat exchange at the bounding surfaces. As confinement tightens in nanoscopic spaces or around singularities, the relationship between frequency and temperature is dictated by the principles of quantum and relativistic thermodynamics.

Problem 3: Find the quantum gravity balance radius **R** for a Particle with a mass of the Planck mass ($m = m_{Planck} = 2.17643\ x 10^{-8} kg$) inside a Quantum singularity with a Planck density ?. Calculate velocity, de Broglie wavelength, vibrational frequency, angular velocity, Photon energy, surface temperature when photon energy and thermal energy are equalized, Quantum gravity energy balance, and Quantum gravity pressure balance of particles in a confined system?.

Solution: In the **First step**, Substitute Physical values in the equation (**16**) to find quantum gravity balance radius **R** of a particle with a Planck mass in a Planck density:

$$\boldsymbol{R = \left(\frac{9\ \hbar^2}{128\ \pi^2\ Gm\rho^2}\right)^{1/7}}.$$

$$\boldsymbol{R} = \left(\frac{9\ x\ (1.054571817\ x 10^{-34}\ \boldsymbol{J.s})^2}{\mathbf{128}\ (3.14)^2\ x \left(\mathbf{6.6743\ x\ 10^{-11}}\ \frac{\boldsymbol{N.m^2}}{\boldsymbol{Kg^2}}\right) x\ (2.17643\ x 10^{-8}\ kg)\ x\ (5.155\ x\ 10^{96}\ Kg/\boldsymbol{m^3})^2}\right.$$

Then, the quantum gravity balance radius is approximately the Planck length scale: ($R = 7.98\ x\ 10^{-36}\ m$). When the density of the particles is increased, its radius decreases. In the **Second step**, Substitute Physical values in the equation (**18**) to find the Quantum velocity of a particle $\boldsymbol{v}$ with a Planck mass **m** in a violent environment at the Planck density:

$$\boldsymbol{v} = \frac{\hbar}{\mathbf{2}\boldsymbol{mR}} = \frac{1.054571817\ x 10^{-34}\ \boldsymbol{J.s}}{2\ x\ 2.17643\ x 10^{-8}\ kg\ x\ 7.98\ x\ 10^{-36}\ m} =$$

$3.03\ x\ 10^8\ m/s$. It is approximately the speed of light ($v = c = 3.03\ x\ 10^8\ m/s$). In the **Third step**, insert values in the equation (**19**) to find the de Broglie wavelength ($\boldsymbol{\lambda}$):

$$\boldsymbol{\lambda} = \frac{\boldsymbol{h}}{\boldsymbol{p}} = \frac{\boldsymbol{h}}{\boldsymbol{mv}} = \frac{6.626\ x 10^{-34}\ \boldsymbol{J.s}}{2.17643\ x 10^{-8}\ kg\ x\ 3.03\ x\ 10^8\ m/s} =$$

$1.01\ x\ 10^{-34}\ m.$ In the **Fourth step**, insert values in the equation (**20**) to find the vibrational frequency ($\boldsymbol{f}$):

$$\boldsymbol{f} = \frac{\boldsymbol{v}}{\boldsymbol{\lambda}} = \frac{\boldsymbol{v}}{\mathbf{2}\boldsymbol{\pi R}} = \frac{3.03\ x\ 10^8\ m/s}{2\pi\ x\ 7.98\ x\ 10^{-36}\ m} = 6.04\ x\ 10^{42}\ Hz.$$

In the **Fifth step**, insert frequency value in the equation (**22**) to find an **angular velocity** ($\boldsymbol{w}$) of particles:

$\boldsymbol{w = 2\pi f = 2\ x\ 3.14\ x}\ 6.04\ x\ 10^{42}\ Hz =$
$3.793\ x\ 10^{43}\ rad/s.$

In the **Sixth step**, substitute values in the equation (**23**) to find **photon energy** ($\boldsymbol{E}$) of particles: $\boldsymbol{E = hf} = \boldsymbol{6.626\ x}\ 10^{-34}\ \boldsymbol{J.s\ x}\ 6.04\ x\ 10^{42}\ Hz = 4002104000\ J.$

In the **seventh step**, insert values into equation (25) to find the **surface temperature** T of the particles when the thermal energy of vibrating particles $\boldsymbol{E_{th}}$ equals the photon energy (E) of the particles in a confined system:

$$\boldsymbol{T} = \frac{\boldsymbol{E=hf}}{\mathbf{1.5}\ \boldsymbol{K_B}} = \frac{(4002104000\ J)}{(\mathbf{1.5\ x\ 1.38\ x\ 10^{-23}}\ \frac{\boldsymbol{J}}{\boldsymbol{K}})} =$$

$\boldsymbol{1.933\ x\ 10^{32}K.}$

This value is approximately the Planck Temperature ($T_{Planck} = 1.41\ x\ 10^{32}K$).

In the **eighth step**, substitute Planck mass **m**, quantum gravity balance radius **R**, and reduced Planck constant approximately $\left(\hbar = \frac{\boldsymbol{h}}{\mathbf{2}\boldsymbol{\pi}} = \mathbf{1.05457\ x\ 10^{-34}}\boldsymbol{J.s}\right)$, in eqn. (**5**) to calculate Heisenberg's quantum energy balance ($\boldsymbol{E_q}$):

$$\boldsymbol{E_q} = \frac{\hbar^2}{\mathbf{8}\boldsymbol{mR^2}} =$$

$$\frac{(\mathbf{1.05457\ x\ 10^{-34}}\boldsymbol{J.s})^2}{(\ \mathbf{8}\ \boldsymbol{x}\ 2.17643\ x 10^{-8}\ kg\ x\ (7.98\ x\ 10^{-36}\ m\ )^2} = \mathbf{1003021752.7}\ \boldsymbol{J}$$

The value of quantum energy and gravitational energy is equalized and approximately ($\boldsymbol{E_q = E_g = 1GJ}$).

In the **Final** steps, insert Planck mass **m**, quantum-gravity balance radius **R**, and reduced Planck constant approximately ($\hbar = \mathbf{1.05457\ x\ 10^{-34}}\boldsymbol{J.s}$), in equation (**13**) to calculate the Heisenberg's quantum pressure ($\boldsymbol{P_q}$):

$$\boldsymbol{P_q} = \frac{\hbar^2}{\mathbf{8}\ \boldsymbol{mR^5}} =$$

$$\frac{(\mathbf{1.05457\ x\ 10^{-34}}\boldsymbol{J.s})^2}{(\ \mathbf{8}\ \boldsymbol{x}\ 2.17643\ x 10^{-8}\ kg\ x\ (7.988\ x\ 10^{-36}\ m\ )^5} = \mathbf{1.96\ x\ 10^{114}}\boldsymbol{Pa.}$$

Then, the Quantum-Gravity Pressure Balance for particle with a Planck mass inside a Planck singularity is approximately $\left(\boldsymbol{P_q = P_g = 1.96\, x\, 10^{114}\, N/m^2}\right)$, When quantum pressure $\boldsymbol{P_q}$ and gravitational pressure $\boldsymbol{P_g}$ are equalized. This is a maximum quantum degenerate pressure of superparticles with Planck mass inside a Planck singularity. The particles could be compressed to Quantum Gravity Balance Radius R, roughly a Planck length, and survived under this tremendous pressure and temperature as superparticles.

11. RESULTS AND DISCUSSION

Quantum foam, also called spacetime foam, it is a theoretical concept in physics suggesting that at the smallest conceivable scales, the Planck scale, the fabric of space and time is not smooth. Instead, it is a chaotic, bubbling broth of quantum fluctuations where particles are constantly created and destroyed, and microscopic wormholes and black holes continuously form and dissolve. The theory predicted by several scientists is that at this small a scale, or at the Planck scale, particles of matter and antimatter are constantly created and destroyed. These small subatomic objects are called virtual particles. The idea was devised decades ago by John Wheeler in 1955. When you zoom in to the unimaginably tiny Planck length, these two theories clash. Because of the Heisenberg Uncertainty Principle, it becomes impossible to perfectly measure both energy and time simultaneously at this tiny scale. This results in massive, violent fluctuations in energy, which, according to Einstein's mass-energy equivalence ($E=mc^2$), translate into fluctuating geometry according to quantum gravity balance. The virtual particles appeared because of quantum energy fluctuations; space is never truly empty. Pairs of virtual matter and antimatter particles continuously spring into existence and annihilate each other almost instantly. At this fundamental level, the smooth, predictable curvature of spacetime warps and twists so violently that it creates a frothy, foamy landscape of tiny wormholes and transient singularities. The Casimir Effect: The presence of a measurable, detected the mysterious force that pushes parallel metal plates together in a vacuum, which scientists attribute to an imbalance of virtual particles between the plates. Cosmic Observations: Some astronomers have used deep-space observatories to study light from distant quasars and gamma-ray bursts to see if it "scatters" as it passes through the foamy, uneven fabric of space over billions of years. Observations generally show spacetime to be incredibly smooth at larger subatomic scales, which helps set limits on how extreme quantum foam can be. Because the quantum foam is a boiling sea of potential, many cosmologists, including Neil deGrasse Tyson, suggest it could hold the key to how the universe was formed. In the chaotic pre-Big Bang state, a rare, massive quantum fluctuation within the foam could have stabilized, inflated, and ultimately expanded into our entire cosmos [56, 57, 58, 59, 60, 61]. The Casimir effect is an experimental prediction that is possibly caused by virtual particles; it is strong evidence and has encouraged scientists to consider the existence of virtual particles. It is possible to measure their effects, confirm their existence, and replicate them in the lab in the future by using new professional technology. The Quantum foam is where superparticles would be formed in a steeply condensed state of matter and energy, typically inside a black hole singularity, due to quantum gravity pressure equilibrium.

The Planck mass is a fundamental unit of mass in physics, representing the scale at which quantum mechanics and gravity intersect. Unlike most subatomic particles, it is tangible on a human scale, it is about $(m_{Planck} = 2.176\, x\, 10^{-8}\, kg)$, roughly the mass of a single eyelash or a dust mite. It is derived exclusively from three universal physical constants: the speed of light (c), the reduced Planck's constant $(\hbar)$, and the gravitational constant (G). Planck density is the theoretical limit of density in the universe, defined as one Planck mass divided by one Planck volume. It represents the upper limit where the laws of quantum mechanics and general relativity merge, beyond which classical physics breaks down. The value of a Planck density is about $(\rho = 5.156\, x\, 10^{96}\, kg/m^3)$. Insert the values of Planck Mass and Planck density into equation (**16**) to find quantum gravity balance radius is about $(\boldsymbol{R = 7.98\, x\, 10^{-36}\, m})$, it is approximately the Planck Length $\left(\boldsymbol{L_{Planck} = 1.6\, x\, 10^{-35}\, m}\right)$. The Planck length is the smallest theoretically measurable distance in physics. It serves as the fundamental boundary where our current theories of quantum mechanics and general relativity collide and break down. Scientists suggest that below this scale, the concept of distance loses all meaning. It is evidence of particle contraction, typically a particle with a Planckian mass to a Planck-length size under Planck-density conditions or inside a Quantum singularity approximately the same as a cosmic mass and an atomic scale. The Planck temperature is the theoretical upper limit of temperature in physics, it is approximately $(T_{Planck} = 1.41\, x\, 10^{32} K)$. It is the hottest possible temperature permitted by the fundamental laws of nature. The surface temperature T of the particle with a Planck mass is about $(T = 1.93\, x\, 10^{32} K)$ when the thermal energy $\boldsymbol{E_{th}}$ equals the photon energy (E) of the compressed particles with a Planck mass in a confined system, typically concentrated particles in the Planck singularity. The particles are survived as superparticles under quantum-gravity-balanced pressure, or degenerate pressure inside a Planckian singularity. Finally insert Planck mass **m**, quantum-gravity balance radius **R**, and reduced Planck constant $(\hbar)$ in equation (**13**) to determine the quantum gravity balance pressure is about $(\boldsymbol{P_g = P_q = 1.96\, x\, 10^{114} Pa})$, and it is approximately the Planck pressure . The particles with a Planck mass survive as superparticles inside a Planck singularity due to this huge quantum degenerative pressure. Planck pressure is the absolute theoretical limit of pressure in the universe, defined as one Planck force applied over one Planck area, its value roughly $(P_{Planck} = 4.63\, x\, 10^{113}\, Pascals)$. It represents the maximum conceivable stress on space itself and serves as the ultimate threshold where the classical laws of general relativity collide directly with quantum mechanics.

Problem 4: Find the quantum gravity balance radius **R** for a Particle with a Bacterium mass $(m = m_{Bacterium} = 1 \text{ picogram} = 1\,x10^{-15}\,kg)$ inside a Quantum singularity with mass of an Andromeda Galaxy that compressed into size of an Iron Atom with radius $(r = 126\,pm)$. Calculate the density of a singularity, velocity, de Broglie wavelength, vibrational frequency, angular velocity, Photon energy, Quantum gravity energy balance, Quantum gravity pressure balance of this particle in a confined system, and find the surface temperature T of a this Particle with a Bacterium mass inside the Singularity sphere when photon energy and thermal energy are equalized ?.

Solution: In the **First step**, I need to calculate the density of a Quantum singularity with the mass of the Andromeda galaxy that compressed to the size of an Iron Atom:

$$(\rho = \frac{M_{\text{Andromeda}}}{Volume\ of\ an\ Iron\ Atom} = \frac{M_{\text{Andromeda}}}{\frac{4}{3}\pi r^3} = \frac{1.5\,x\,10^{42} Kg}{\frac{4}{3}\pi(1.26\,x\,10^{-10}\,m)^3}.$$

$$(\rho = 1.79\,x\,10^{71}\,\frac{Kg}{m^3}).$$

Substitute the value of a Particle with a Bacterium mass $(m = m_{Bacterium} = 1 \text{ picogram} = 1\,x10^{-15}\,kg)$, and the value of a Singularity density ρ in the equation (**16**) to find quantum gravity balance radius **R** of a compressed particle with a Bacterium mass in a Quantum Singularity:

$$\boldsymbol{R} = \left(\frac{9\,\hbar^2}{128\,\pi^2\ G m\rho^2}\right)^{1/7}.$$

$$\boldsymbol{R} = \left(\frac{9\,x\,(1.054571817\,x10^{-34}\,J.s)^2}{128\,(3.14)^2\,x\left(6.6743\,x\,10^{-11}\,\frac{N.m^2}{Kg^2}\right)x\,(1\,x10^{-15}\,kg)\,x\,(1.79\,x\,10^{71}\,Kg/m^3)^2}\right)^{1/7}$$

Then, the quantum gravity balance radius is approximately: $(R = 1.7\,x\,10^{-27}\,m)$. In the **Second step**, Substitute Physical values in the equation (**18**) to find the Quantum velocity of a particle $\boldsymbol{v}$ with a Bacterium mass **m** in a violent environment at the Quantum Singularity with mass of an Andromeda Galaxy:

$$\boldsymbol{v} = \frac{\hbar}{2mR} = \frac{1.054571817\,x10^{-34}\,J.s}{2\,x\,1\,x\,10^{-15}\,kg\,x\,1.7\,x\,10^{-27}\,m} = 3.10\,x\,10^7\,m/s.$$

Final velocity of this particle is v = 31,016,818.15 m/s, approximately 10.3% of the speed of light. In the **Third step**, insert values in the equation (**19**) to find the de Broglie wavelength ($\boldsymbol{\lambda}$):

$$\boldsymbol{\lambda} = \frac{h}{p} = \frac{h}{mv} = \frac{6.626\,x10^{-34}\,J.s}{1\,x10^{-15}\,kg\,x\,3.10\,x\,10^7\,m/s} = 2.14\,x\,10^{-26}\,m.$$

In the **Fourth step**, insert values in the equation (**20**) to find the vibrational frequency ($\boldsymbol{f}$):

$$\boldsymbol{f} = \frac{v}{\lambda} = \frac{v}{2\pi R} = \frac{3.10\,x\,10^7\,m/s}{2\pi\,x\,1.7\,x\,10^{-27}\,m} = 2.90\,x\,10^{33}\,Hz.$$

In the **Fifth step**, insert frequency value in the equation (**22**) to find an **angular velocity** ($\boldsymbol{w}$) of particles:

$$\boldsymbol{w = 2\pi f = 2\,x\,3.14\,x}\,2.90\,x\,10^{33}\,Hz = 1.82\,x\,10^{34}\,rad/s.$$

In the **Sixth step**, substitute values in the equation (**23**) to find **photon energy** ($\boldsymbol{E}$) of particles: $\boldsymbol{E = hf = 6.626\,x}\,10^{-34}\,\boldsymbol{J.s\,x}\,2.90\,x\,10^{33}\,Hz = 1.92\,J.$ It is an extremely ultra-relativistic gamma-ray scale.

In the **seventh step**, insert values into equation (25) to find the **surface temperature** T of the particles when the thermal energy $\boldsymbol{E_{th}}$ equals the photon energy (E) of the particle with a Bacterium mass in this confined regime:

$$\boldsymbol{T} = \frac{E=hf}{1.5\,K_B} = \frac{(1.92\,J)}{(1.5\,x\,1.38\,x\,10^{-23}\,\frac{J}{K})} = \boldsymbol{9.27\,x\,10^{22}K}.$$

The value of this temperature much lower than a Planck Temperature $(T_{Planck} = 1.41\,x\,10^{32}K)$ due to lower mass and density of this singularity.

In the **eighth step**, substitute Bacterium mass **m**, quantum gravity balance radius **R**, and reduced Planck constant approximately $\left(\hbar = \frac{h}{2\pi} = \boldsymbol{1.05457\,x\,10^{-34}J.s}\right)$, in eqn. (**5**) to calculate Heisenberg's quantum energy balance ($\boldsymbol{E_q}$):

$$\boldsymbol{E_q} = \frac{\hbar^2}{8mR^2} = \frac{(1.05457\,x\,10^{-34}J.s)^2}{(\,8\,x\,1\,x10^{-15}\,kg\,x\,(1.7\,x\,10^{-27}\,m\,)^2} = \boldsymbol{0.48\,J}.$$

The value of quantum energy and gravitational energy is equalized and approximately ($\boldsymbol{E_q = E_g = 0.48\,J}$).

In the **Final** steps, insert Bacterium mass **m**, quantum-gravity balance radius **R**, and reduced Planck constant approximately $(\hbar = \boldsymbol{1.05457\,x\,10^{-34}J.s})$, in equation (**13**) to calculate the Heisenberg's quantum pressure ($\boldsymbol{P_q}$):

$$\boldsymbol{P_q} = \frac{\hbar^2}{8\,mR^5} = \frac{(1.05457\,x\,10^{-34}J.s)^2}{(\,8\,x\,1\,x10^{-15}\,kg\,x\,(1.7\,x\,10^{-27}\,m\,)^5} = \boldsymbol{9.8\,x\,10^{79}Pa}.$$

Then, the Quantum-Gravity Pressure Balance is approximately $\left(\boldsymbol{P_q = P_g = 9.8\,x\,10^{79}\,N/m^2}\right)$, When quantum pressure $\boldsymbol{P_q}$ and gravitational pressure $\boldsymbol{P_g}$ are equalized. This is a maximum quantum degenerate pressure of particles with a Bacterium mass inside a Galactic mass singularity. The particles could be compressed to this tiny scale, and survived under this tremendous pressure and temperature. Then these particles behave like superparticles with a quantum-degeneracy pressure.

The stellar cluster with mass of million Suns $(M = 1.989\,x\,10^{35}\,kg)$ has been compressed to the size of an Iron Atom with radius r=126 pm to form a Quantum Singularity with a density $(\rho = \boldsymbol{2.37\,x\,10^{64}\,kg/m^3})$. Quantum Gravity Balance Radius R of a particle with mass of Sodium Chloride (NaCl) $(m = \boldsymbol{9.715\,x\,10^{-26}\,kg})$ inside this singularity is $(\boldsymbol{R} = 4.2\,x\,10^{-24}\,m)$ and quantum pressure approximately $(\boldsymbol{P_q = 1.1\,x\,10^{73}Pa})$. In Quantum gravity physics, this scenario describes a microscopic particle with a mass of NaCl trapped and concentrated inside a quantum singularity with a mass of a million suns. When a particle falls into an event horizon of a black hole, it gets pulled toward the center. However, we can look at the properties of the black hole itself based on the mass of a stellar cluster. We can also look at the quantum size of a single molecule of salt using quantum gravity balance equations. The salt particle could be dragged, trapped, crushed and squeezed steeply inside a singularity with a stellar cluster mass by quantum pressure, quantum gravity balance radius, and tremendous temperature.

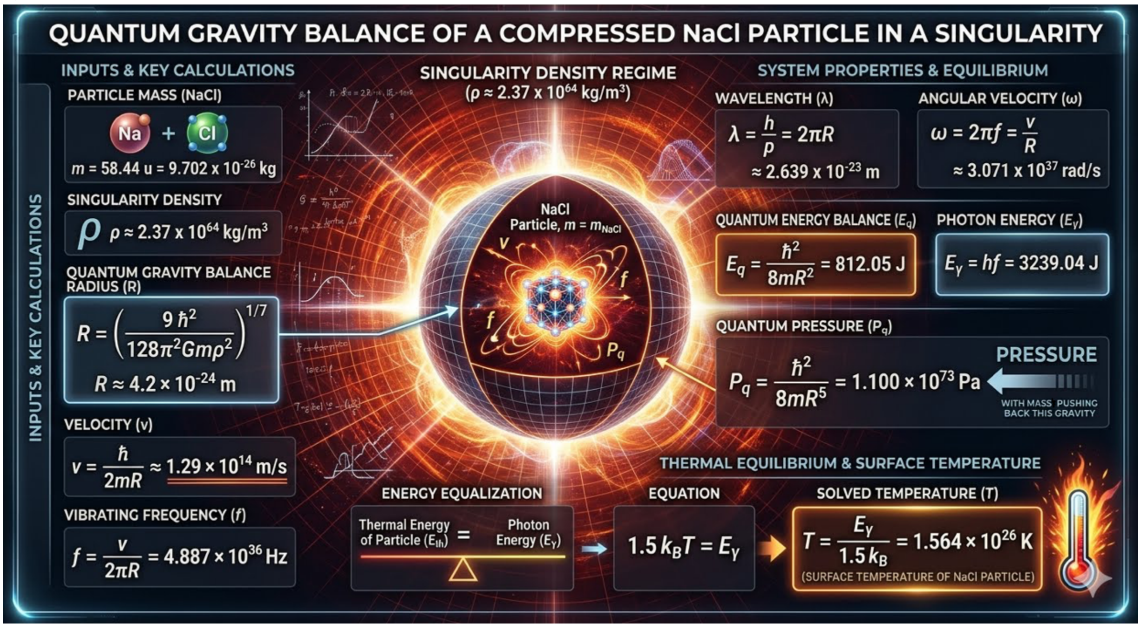

Fig. 4. The Quantum Gravity Balance Radius R and Surface Temperature T of a Particle with the mass m of Sodium Chloride (NaCl) inside a Quantum Singularity with the Mass of a Stellar Cluster M and radius of an Atom r.

The black hole singularity with mass of Sun ($M = 1.989\ x\ 10^{30}\ kg$) has been compressed to the size of Hydrogen Atom with radius r=52.9 pm to form a Quantum Singularity with a density ($\rho = 3.21\ x\ 10^{60}\ kg/m^3$). Quantum Gravity Balance Radius R of a particle with mass of Proton or Hydrogen Atom approximately ($m = m_p = 1.673\ x\ 10^{-27}\ kg$) inside this Quantum singularity is ($R = 9.48\ x\ 10^{-23}\ m$) and quantum pressure approximately ($P_q = 1.1\ x\ 10^{68} Pa$). The physical properties of a proton-mass particle under these conditions are entirely well defined by extreme gravity, which causes the particle to lose its identity, get torn apart by immense tidal forces, and experience a forced collapse toward a tiny volume point. In classical physics, a "singularity" has zero size. Packing the mass of the Sun into the size of a hydrogen atom means creating an object much smaller than a standard black hole's boundary. A star with the mass of our Sun naturally forms a black hole with a boundary (Schwarzschild radius) of about 3000 meters. Because a hydrogen atom is only about 52.9 pm wide, this object is already deep inside its own event horizon, where space and time twist. A massive object packed into the size of an atom. According to Einstein's Theory of General Relativity, the gravity is so strong that nothing can hold it up. The entire boundary will actively crush downward. The particle will not sit still; it is forced to move toward the center at nearly the speed of light. Inside this system, a proton-mass particle cannot maintain its normal physical properties. It is stripped of its structure by 3 billion Newtons of tidal force, dissolved into quarks, and forced into a continuous collapse toward a point of higher density. Quantum gravity balance pressure is necessary to suspend this contraction and the compression of a singularity to the size of an atom to form a Quantum singularity with the mass of stars and the size of atoms. The particle with subatomic mass would be trapped, concentrated, collapsed, and reduced in size to lower than zeptometres to form quantum foam of superparticles inside a quantum singularity with mass of stars and size of atoms.

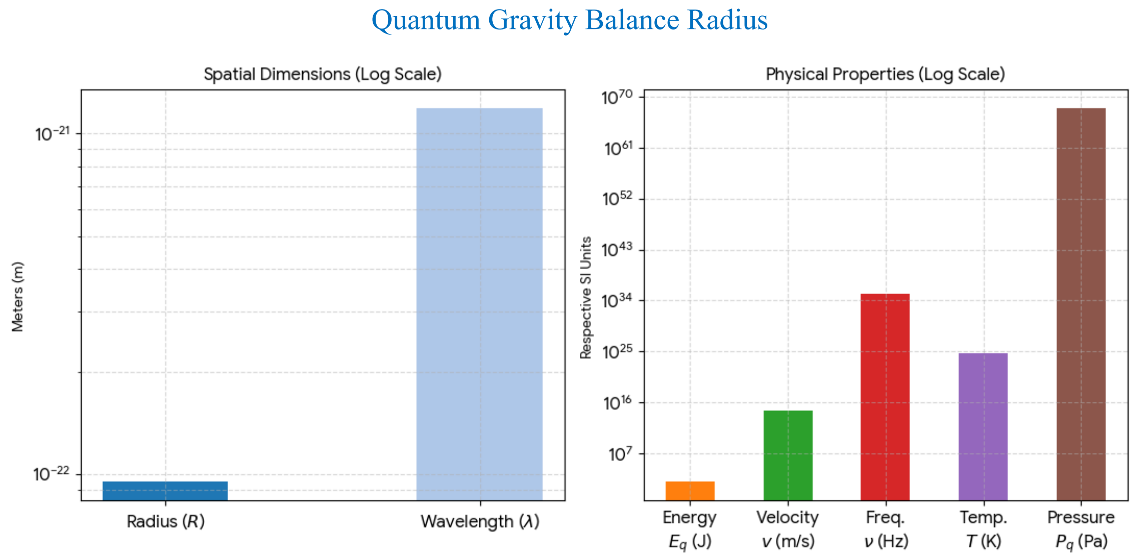

Fig. 5. Physical Properties of particles with a mass of a proton inside a Quantum Singularity with the mass of the Sun and the size of a Hydrogen Atom.

The Star with mass of a Sun ($M = 1.989\ x\ 10^{30}\ kg$) has been compressed to the radius r=3 km to form a Black Hole with a density ($\rho = 1.76\ x\ 10^{19}\ kg/m^3$). Quantum Gravity Balance Radius R of a particle with mass of Hydrogen Atom ($m = m_H = 1.673\ x\ 10^{-27}\ kg$) inside a Black dwarf becomes ($R = 5.83\ x\ 10^{-11}\ m$) and quantum pressure approximately ($P_q = 1.23\ x\ 10^9 Pa = 1.23\ GPa$). Then R=58.3 pm is the radius, or the distance between two hydrogen atoms that are stuck outside a solar-mass black hole. The hydrogen atom would stick to the edge of a black hole and remain in the same size. The surface temperature of a hydrogen atom at the edge of a black hole was very low, about 47.5 K, due to its distant location from the tidal effects of a black hole singularity. The hydrogen atoms and total types of atoms in the periodic table could be compressed to the size of subatomic particles or fabritons when they are dragged inward to the center of a black hole. The Star with mass of two Suns ($M = 2\ x\ 1.989\ x\ 10^{30}\ kg$) has been compressed to the radius r=13.2 km to form a Neutron Star with a density approximately ($\rho = 4.13\ x\ 10^{17}\ kg/m^3$). Quantum Gravity Balance Radius R or intermediate distance of particles with mass of a Neutron particle ($m = m_N = 1.675\ x\ 10^{-27}\ kg$) at the edge of a Neutron star approximately ($R = 1.7\ x\ 10^{-10}\ m$) and quantum pressure is ($P_q = 5.85\ x\ 10^6 Pa = 5.85\ MPa$). Then R=0.17 nm is the radius, or the distance between two neutron particles that are stuck outside a neutron star. Neutrons would stick to the edge of a neutron star and remain the same size. The surface temperature of a neutron particle at the distant location of a neutron star was very low, about 5.55 K, due to its distance from the tidal effects of the Neutron star. The neutron particles and total types of subatomic particles could be compressed to the size of fabritons when they are dragged inward to the center of a neutron star.

The Star with mass of Sun ($M = 1.989\ x\ 10^{30}\ kg$) has been compressed to the radius approximately to the radius of Earth r=6371 km to form a white dwarf Star with a density ($\rho = 1.84\ x\ 10^9\ kg/m^3$). Quantum Gravity Balance Radius R or intermediate distance of particles with mass of an electron particle ($m = m_e = 9.109\ x\ 10^{-31}\ kg$) at the edge of a white dwarf star approximately ($R = 1.21\ x\ 10^{-7}\ m$) and quantum pressure very low about ($P_q = 5.88\ x\ 10^{-5}\ Pa$). Then (d=R) is the radius, wavelength of electron particles or the distance between two electron particles that are stuck outside a white dwarf star due to lower quantum gravity effect. The frequency of an electron particle at the edge of a white dwarf approximately ($f = 6.30\ x\ 10^8\ Hz$) and its surface temperature changed very low about ($T = 2\ x\ 10^{-2}\ K$). Electrons would stick to the edge of a white dwarf and remain the same size because the quantum gravity pressure effects of neutron stars, white dwarf stars, and celestial objects on the particles at distant locations are very low. The role of quantum gravity balance in the distortion and compression of particles is slightly lower for objects with lower density as compared to the black hole singularity with higher density. Electron degeneracy pressure worked well in white dwarfs, neutron degeneracy pressure initiated at neutron stars, and thermal gravity balance started at the heart of massive stars to form new atoms. Then superparticle degeneracy pressure by the quantum gravity balance principle worked well to suspend the singularity from further contraction and annihilation. Superparticles degeneracy pressure is the phenomena occurred in the ultra-dense regime, typically at the heart of black holes, inside the singularity sphere. The quantum gravity pressure effect that is released from normal objects with lower density is not high enough to cause changes in the structure of atoms and particles, but it plays a necessary role in keeping particles at limited distances from one another or expanding particles. Particles at the edge of stars, planets, and black holes could be captured, compressed, and concentrated to hold together slightly or tightly due to the quantum gravity principle. The quantum gravity balance principle plays an essential role in the formation and evolution of celestial objects, the multiverses, and the visible universe.

The star with mass of Sun ($M = 1.989\ x\ 10^{30}\ kg$) has been compressed to the size of hydrogen atom to form a black hole singularity with a density ($\rho = 3.21\ x\ 10^{60}\ kg/m^3$). Quantum Gravity Balance Radius R or intermediate distance of particles with mass of Fabriton particles ($m = m_F = 9.109\ x\ 10^{-41}\ kg$) at the edge of a singularity sphere approximately ($R = 7.44\ x\ 10^{-21}\ m$). Its quantum pressure very high about ($P_q = 6.67\ x\ 10^{71}\ Pa$). The frequency of a Fabriton particle at the edge of a singularity is ($f = 1.66\ x\ 10^{45}\ Hz$) and its surface temperature changed very high to ($T = 5.32\ x\ 10^{34}\ K$). Fabriton particles are a theoretical dark matter candidate proposed by the physicist Sabir Sadiq [62]. Introduced in his research papers on astronomy and gravitation. The theory suggests these particles occupy the spaces within atoms (between the nucleus and electrons) to hold them together, while also bridging the massive distances between stars and planets to hold stellar systems together as Atomic and Cosmic Glue. Inside supergiant black holes and singularities, extreme gravitational forces can compress and collapse dark fabriton particles, forcing them to annihilate and transform into ordinary matter and energy. In proposed theoretical frameworks (such as the "fabriton" model for dark matter particles), a fabriton particle is estimated to have an extremely tiny mass and size.

Table 1: Quantum Gravity Balance Radius of Particles in a Confined System

Density of Objects (ρ)	**Mass of Particles (m)**	**Quantum Gravity Balance Radius** $R = \left(\frac{9\ \hbar^2}{128\ \pi^2\ Gm\rho^2}\right)^{1/7}$	**Quantum Gravity Pressure** $P_q = \frac{\hbar^2}{8\ mR^5}$
$\mathbf{5.15\ x\ 10^{96}\ kg/m^3}$	$2.176\ x\ 10^{-8}\ kg$	$7.98\ x\ 10^{-36}\ m$	$1.96 \text{ x } 10^{114}$Pa
$\mathbf{1.79\ x\ 10^{71}\ \frac{Kg}{m^3}}$	$1\ x10^{-15}\ kg$	$1.7\ x\ 10^{-27}\ m$	$9.8\ x\ 10^{79} Pa$
$\mathbf{2.37\ x\ 10^{64}\ kg/m^3}$	$9.71\ x10^{-26}\ kg$	$4.2\ x\ 10^{-24}\ m$	$1.1\ x\ 10^{73} Pa$
$\mathbf{3.21\ x\ 10^{60}\ kg/m^3}$	$1.673\ x10^{-27}\ kg$	$9.48\ x\ 10^{-23}\ m$	$1.1 \text{ x } 10^{68}$Pa
$\mathbf{1.76\ x\ 10^{19}\ kg/m^3}$	$1.673\ x10^{-27}\ kg$	58.3 pm	$1.23\ GPa$
$\mathbf{4.13\ x\ 10^{17}\ kg/m^3}$	$1.675\ x10^{-27}\ kg$	$1.7\ x10^{-10}\ m$	$5.85\ MPa$
$\mathbf{1.84\ x\ 10^{9}\ kg/m^3}$	$9.109\ x10^{-31}\ kg$	$1.21\ x\ 10^{-7}\ m$	$5.88\ x\ 10^{-5}\ Pa$

12. CONCLUSION

Quantum gravity balances in dense systems work by blending gravity with quantum mechanics to stop total collapse. In extreme objects like black holes, standard physics breaks down because gravity becomes infinitely strong. Quantum gravity introduces a fundamental limit where space and time cannot shrink any further, replacing infinite collapse and infinite density with a stable balance of radius, pressure, energy, frequency, and temperature. The tussle between gravitational energy and thermal energy prevents stars from collapsing. Electron degeneracy pressure keeps on the white dwarf stars, neutron degeneracy pressure enhanced the stability of neutron stars, and superparticles degeneracy pressure prevented the black hole singularity from additional contraction and collapsing by Quantum Gravity Pressure Balance. Indeed, our visible Universe is a Planck Singularity (Cosmic Seed) that formed within the Parent Supergiant Black Hole before the Big Bang and cosmic inflation, then this seed escaped into the Cosmic Void and evaporated into matter, energy, atoms, photons, particles, stars, galaxies, black holes, and whole celestial objects in our Universe. An escape velocity of particles from the external surface of a black hole singularity exceeded the speed of light. The speed of Superparticles may exceed light-years per second to quadrillion light-years per second, typically from parent supergiant black holes. We need to travel quadrillion light-years per second to visit neighbouring universes. You should see the galaxy clusters and entire cosmic web in bright yellowish colour when you travel over the visible universe.

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Dears and Colleagues, I am ***Sabir Sadiq****, a Physics Lecturer, Researcher in the Astrophysics Field, Organizer, Volunteer, and General President of the Kurdistan Space Agency. We appreciate the cooperation with the* ***Kurdistan Space Agency****.*

Conflict of Interest

I declare that I have no conflict of interests.

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REFERENCES

1. Cheung, Y.-K.E.; Li, C.; Vergados, J.D. Big Bounce Genesis and Possible Experimental Tests: A Brief Review. *Symmetry* 2016, *8*, 136. https://doi.org/10.3390/sym8110136.
2. Moriconi, R., Montani, G. and Capozziello, S., 2016. Big-bounce cosmology from quantum gravity: The case of a cyclical Bianchi I universe. Physical Review D, 94(2), p.023519. DOI: https://doi.org/10.1103/PhysRevD.94.023519.
3. J. Garcia-Bellido, E. Ruiz Morales. Primordial black holes from single field models of inflation. Phys. Dark Universe, 18 (2017), p. 47-54. https://doi.org/10.1016/j.dark.2017.09.007.
4. Sadiq, Sabir. 2026. "Angular Momentum and Surface Temperature of the Singularity and Superparticles". *Engineering And Technology Journal* 11 (06):10514-30. https://doi.org/10.47191/etj/v11i06.27.
5. Ngo, Hai N., Dieu D. Nguyen, Tinh Q. T. Le, Khue N. H. Ho, Tien H. T. Ho, Elena Gallo, Kristina Nyland, Masatoshi Imanishi, Kouichiro Nakanishi, and Que T. Le. 2025. "Revisiting the Supermassive Black Hole Mass of NGC 7052 Using High Spatial Resolution Molecular Gas Observed with ALMA." The Astrophysical Journal 992 (2): 211. DOI 10.3847/1538-4357/ae0455.
6. Rahikainen, A. (2023) Theory to the Mystery of the Super Massive Black Holes. World Journal of Mechanics, 13, 107-126. doi: 10.4236/wjm.2023.135006.
7. Kuo C-Y. Measuring Supermassive Black Hole Masses with H_2O Megamasers: Observations, Methods, and Implications for Black Hole Demographics. *Universe*. 2025; 11(12):415. https://doi.org/10.3390/universe11120415.
8. Giuseppe Lodato, Priyamvada Natarajan, Supermassive black hole formation during the assembly of pre-galactic discs, Monthly Notices of the Royal Astronomical Society, Volume 371, Issue 4, October 2006, Pages 1813–1823, https://doi.org/10.1111/j.1365-2966.2006.10801.x.
9. Marta Volonteri, Giuseppe Lodato, Priyamvada Natarajan, The evolution of massive black hole seeds, Monthly Notices of the Royal Astronomical Society, Volume 383, Issue 3, 21 January 2008, Pages 1079–1088, https://doi.org/10.1111/j.1365-2966.2007.12589.x.
10. Natarajan, P. Seeds to monsters: tracing the growth of black holes in the universe. *Gen Relativ Gravit* 46, 1702 (2014). https://doi.org/10.1007/s10714-014-1702-6.
11. G. B. Mainland and Bernard Mulligan 2019 *J. Phys.: Conf.Ser.* 1239 012016DOI 10.1088/1742-6596/1239/1/012016.
12. Mainland, G. B., and Bernard Mulligan. 2019. "How Vacuum Fluctuations Determine the Properties of the Vacuum." Journal of Physics: Conference Series 1239 (1): 012016. https://doi.org/10.1088/1742-6596/1239/1/012016.
13. Hilgevoord, Jan. "The uncertainty principle for energy and time." American Journal of Physics, vol. 64, no. 12, 1996, pp. 1451–1456. AIP Publishing. https://doi.org/10.1119/1.18410.
14. Ringbauer, M.; Biggerstaff, D.N.; Broome, M.A.; Fedrizzi, A.; Branciard, C.; White, A.G. (2014). "Experimental Joint Quantum Measurements with Minimum Uncertainty". Physical Review Letters. 112 (2) 020401. arXiv:1308.5688. Bibcode:2014PhRvL.112b0401R. doi:10.1103/PhysRevLett.112.020401. PMID 24483993. S2CID 18730255.
15. Michaud, A. (2024) Critical Analysis of the Origins of Heisenberg's Uncertainty Principle. Journal of Modern Physics, 15, 765-795. doi: 10.4236/jmp.2024.156034.
16. Clayton, Donald D., and Bradley S. Meyer. 2016. "The secondary supernova machine: Gravitational compression, stored Coulomb energy, and SNII displays." New Astronomy Reviews 71: 1-13.
17. Siyao Xu and Alex Lazarian 2020 *ApJ* 899 115DOI 10.3847/1538-4357/aba7ba.
18. Capozziello, S., Capriolo, M., & Lambiase, G. (2026). Gravitational energy-momentum pseudotensor in f(Q) nonmetric gravity. *Physical Review D*, *113*(4), Article 044017. https://doi.org/10.1103/1kvt-vvcf.
19. Beckwith, A. (2016) Thermodynamics and the Energy of Gravity Waves, GW's, as a Consequence of Non Linear Electrodynamics, NLED, Leading to an Initial Temperature and Strain h for Gravity Waves, GW, at the Start of Inflation. Journal of High Energy Physics, Gravitation and Cosmology, 2, 98-105. doi: 10.4236/jhepgc.2016.21011.
20. MCVITTIE, G. Gravitational Collapse. *Nature* 203, 286–287 (1964). https://doi.org/10.1038/203286a0.
21. Haug, E. (2025) Quantum Cosmology: Cosmology Directly Linked to the Planck Scale in General Relativity Theory and Newton Gravity: The Link between Microcosmos and Cosmos. Open Journal of Microphysics, 15, 1-23. doi: 10.4236/ojm.2025.151001.
22. Andrew M Low 2024 *Phys. Educ.* **59** 015013, DOI 10.1088/1361-6552/acfe54.
23. Robbers, Georg, Niayesh Afshordi, and Michael Doran. 2008. "Does the Planck Mass Run on the Cosmological-Horizon Scale?" Physical Review

Letters 100 (11): 111101. DOI: https://doi.org/10.1103/PhysRevLett.100.111101.
24. Rovelli, Carlo; Vidotto, Francesca (8 February 2014). "Planck stars". Physics. 23 (12). arXiv:1401.6562. Bibcode:2014IJMPD..2342026R. doi:10.1142/S0218271814420267.
25. Carlo Rovelli (10 December 2018). "Viewpoint: Black Hole Evolution Traced Out with Loop Quantum Gravity". Physics. 11. arXiv:1901.04732. Retrieved 11 December 2018.
26. C. Rovelli and F. Vidotto, "Evidence for Maximal Acceleration and Singularity Resolution in Covariant Loop Quantum Gravity," Physical Review Letters 111 (Aug., 2013) 091303, arXiv:1307.3228.
27. Carroll, Sean M.; Kaplinghat, Manoj (27 February 2002). "Testing the Friedmann equation: The expansion of the universe during big-bang nucleosynthesis". Physical Review D. 65 (6) 063507. arXiv:astro-ph/0108002. Bibcode:2002PhRvD..65f3507C. doi:10.1103/PhysRevD.65.063507. ISSN 0556-2821.
28. Peebles, P. J. E.; Ratra, Bharat (22 April 2003). "The cosmological constant and dark energy". Reviews of Modern Physics. 75 (2): 559–606. arXiv:astro-ph/0207347. Bibcode:2003RvMP...75..559P. doi:10.1103/RevModPhys.75.559. ISSN 0034-6861. S2CID 118961123.
29. Turyshev, Slava G. (November 2008). "Experimental Tests of General Relativity". Annual Review of Nuclear and Particle Science. 58 (1): 207–248. arXiv:0806.1731. Bibcode:2008ARNPS..58..207T. doi:10.1146/annurev.nucl.58.020807.111839. S2CID 119199160.
30. Goodman, Jeremy (15 August 1995). "Geocentrism reexamined" (PDF). Physical Review D. 52 (4): 1821–1827. arXiv:astro-ph/9506068. Bibcode:1995PhRvD..52.1821G. doi:10.1103/PhysRevD.52.1821. PMID 10019408. S2CID 37979862. Archived (PDF) from the original on 2 May 2019. Retrieved 2 December 2019.
31. Popławski, N. (2016). Universe in a black hole in Einstein–Cartan gravity. The Astrophysical Journal, 832(2), 96. DOI: 10.3847/0004-637X/832/2/96.
32. S. Desai, N. J. Popławski (2016). "Non-parametric reconstruction of an inflaton potential from Einstein–Cartan–Sciama–Kibble gravity with particle production". Physics Letters B. 755: 183–189. arXiv:1510.08834. Bibcode:2016PhLB..755..183D. doi:10.1016/j.physletb.2016.02.014. S2CID 55366841.
33. F. R. Benard Guedes, N. J. Popławski (2024). "General-relativistic wave–particle duality with torsion". Classical and Quantum Gravity. 41 (6): 065011. arXiv:2211.03234. doi:10.1088/1361-6382/ad1fcb.
34. N. J. Popławski (2014). "The energy and momentum of the Universe". Classical and Quantum Gravity. 31 (6) 065005. arXiv:1305.6977. Bibcode:2014CQGra..31f5005P. doi:10.1088/0264-9381/31/6/065005. S2CID 118593046.
35. N. Popławski (2021). "Gravitational collapse of a fluid with torsion into a universe in a black hole". Journal of Experimental and Theoretical Physics. 132 (3): 374–380. arXiv:2008.02136. Bibcode:2021JETP..132..374N. doi:10.1134/S1063776121030092.
36. Gaztanaga E. The Black Hole Universe, Part I. *Symmetry*. 2022; 14(9):1849. https://doi.org/10.3390/sym14091849.
37. Khlopov, M.; Paik, B.; Ray, S. Revisiting Primordial Black Hole Evolution. *Axioms* 2020, *9*, 71. https://doi.org/10.3390/axioms9020071.
38. Roupas, Z. Massive Black Hole Formation in Proto-Stellar Clusters via Early Gas Accretion. Particles 2026, 9, 18. https://doi.org/10.3390/particles9010018.
39. Sadiq, S. 2025 "Hydrostatic Balance of Stars and Black Hole Singularity" Preprints. https://doi.org/10.20944/preprints202509.1636.v1.
40. Pei, T.-H. The Black Hole with a Finite-Sized Core Structure. *Symmetry* 2025, *17*, 1431. https://doi.org/10.3390/sym17091431.
41. Oei, M.S.S.L., Hardcastle, M.J., Timmerman, R. *et al.* Black hole jets on the scale of the cosmic web. *Nature* 633, 537–541 (2024). https://doi.org/10.1038/s41586-024-07879-y.
42. Neronov, A., Vazza, F., Brandenburg, A., & Caprini, C. (2025). Intergalactic magnetism in a gamma-ray beam as a model of Porphyrion. *Astronomy & Astrophysics*, *696*, L8. https://doi.org/10.1051/0004-6361/202453099.
43. Ribeiro, Andre L. B., and Nathalia M. N. da Rocha. 2026. "Future Perspectives on Black Hole Jet Mechanisms: Insights from Next-Generation Observatories and Theoretical Developments" *Universe* 12, no. 1: 24. https://doi.org/10.3390/universe12010024.
44. Sadiq, S. 2026. Distortion and Heating an Accretion Disc of a Black Hole. Engineering And Technology Journal. 11, 01 (Jan. 2026), 8680–8696. DOI:https://doi.org/10.47191/etj/v11i01.33.
45. Sadiq, S. (2026). Plasma Jets and Stellar Lightnings Involved in Coronal Heating Dynamics. Preprints. https://doi.org/10.20944/preprints202606.0563.v1.
46. Syed Ayaz et al 2024 ApJ 970 140. DOI 10.3847/1538-4357/ad5bdc.
47. R. Sadeghi, E. Tavabi. 23 December 2024 .Characterizing Solar Spicules and their Role in Solar Wind Production using Machine Learning and the

Hough Transform.
DOI: 10.48550/arXiv.2408.07168.

48. E. Tavabi et al 2018 ApJ 866 35. DOI 10.3847/1538-4357/aadc64.
49. Zeighami, S., Ahangarzadeh Maralani, A.R., Tavabi, E. *et al.* Evidence of Energy Supply by Active-Region Spicules to the Solar Atmosphere. *Sol Phys* 291, 847–858 (2016). https://doi.org/10.1007/s11207-016-0866-5.
50. A. R. Ahangarzadeh Maralani, E. Tavabi, A. Ajabshirizadeh, Evidence for coherent spicule oscillations from correcting Hinode/SOT Ca ii H in the south-east limb of the Sun, Monthly Notices of the Royal Astronomical Society, Volume 467, Issue 3, June 2017, Pages 3393–3398, https://doi.org/10.1093/mnras/stx300.
51. Berti, E., Cardoso, V., Carullo, G., Albanesi, S., Baibhav, V., Bhagwat, S., Bucciotti, B., Cano, P. A., Cheung, M. H.-Y., & Chung, K.-W. (2026). Black hole spectroscopy: from theory to experiment. Classical and Quantum Gravity. Advance online publication. https://doi.org/10.1088/1361-6382/ae59e2.
52. Singh, H., Nandy, M.K. Quantum black holes in scalar–tensor gravity: a Green function approach. *Eur. Phys. J. C* 85, 1365 (2025). https://doi.org/10.1140/epjc/s10052-025-15099-5.
53. Tessarotto, Massimo, and Claudio Cremaschini. 2025. "Quantum Gravity Spacetime: Universe vs. Multiverse" *Entropy* 27, no. 11: 1168. https://doi.org/10.3390/e27111168.
54. Aziz, J., Howl, R. Classical theories of gravity produce entanglement. *Nature* 646, 813–817 (2025). https://doi.org/10.1038/s41586-025-09595-7.
55. Agafonova, S., Rosselló, P., Mekonnen, M. *et al.* One-milligram torsional pendulum toward experiments at the quantum-gravity interface. *Commun Phys* 9, 80 (2026). https://doi.org/10.1038/s42005-026-02514-w.
56. Wheeler, J. A. (January 1955). "Geons". Physical Review. 97 (2): 511–536. Bibcode:1955PhRv...97..511W. doi:10.1103/PhysRev.97.511.
57. Wheeler, John Archibald; Ford, Kenneth Wilson (2010) [1998]. Geons, black holes, and quantum foam : a life in physics. New York: W. W. Norton & Company. p. 328. ISBN 9780393079487. OCLC 916428720.
58. Vasileiou, Vlasios; Granot, Jonathan; Piran, Tsvi; Amelino-Camelia, Giovanni (2015). "A Planck-scale limit on spacetime fuzziness and stochastic Lorentz invariance violation". Nature Physics. 11 (4): 344–346. Bibcode:2015NatPh..11..344V. doi:10.1038/nphys3270.
59. Hawking, Stephen W. (November 1978). "Spacetime foam". Nuclear Physics B. 144 (2–3): 349–362. Bibcode:1978NuPhB.144..349H. doi:10.1016/0550-3213(78)90375-9.
60. Steinbring, E. Holographic Quantum-Foam Blurring Is Consistent with Observations of Gamma-Ray Burst GRB221009A. *Galaxies* 2023, *11*, 115. https://doi.org/10.3390/galaxies11060115.
61. Ng, Y.J. Spacetime Foam: From Entropy and Holography to Infinite Statistics and Nonlocality. *Entropy* 2008, *10*, 441-461. https://doi.org/10.3390/e10040441.
62. Sadiq, Sabir. 2025. “Mass and Radius of a Fabriton Particle”. Engineering And Technology Journal 10 (2):3886-99. https://doi.org/10.47191/etj/v10i02.18.