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The Formulas for Calculating Surface Gravity and Rotational period of Celestial Bodies and Black Hole in Axial Spherical-Space

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Abstract
This paper presents a formula for calculating the average surface gravity of a rotating object, derived from Hoffman-Wellenhof's definition and modern physics. The formula reveals a constant physical and mathematical relationship between the average surface gravity, average rotational period, total mass, and average radius of a celestial body that rotates around its axis. Consequently, two additional formulas have been developed: one for determining the average rotational period of celestial bodies, such as planets in the Solar system, stars, and neutron stars in the Milky Way system; and another for calculating the rotational period of a black hole. These three formulas are distinguished by their simplicity, precision, and reliability. Furthermore, the theory of axial spherical-space serves as a complement to universal gravitation and relativity in explaining the nature of spin, magnetic fields, and light.

Keywords: Gravity, Period, Rotation, Planet, Star, Black-Hole

1. Introduction

Every physicist knows that understanding celestial rotation has gone through a long historical process. In 499 AD, an Indian astronomer Aryabhata proposed that the spherical Earth rotates around its axis every day from [1]. It was not until 1543, when Nicholas Copernicus adopted the heliocentric world system that contemporary understandings of the Earth's rotation began to be established. During the period from 1543 to this year, although many great physicists and astrophysicists and their theories were born, such as Newton and his theory of universal gravitation $\left(F = \frac{GMm}{R^2}\right)$, Kepler and his formula for calculating the orbital period $\left(T^2 = \frac{4\pi^2 R^3}{G(M+m)}\right)$ of planet and Einstein and his theory of relativity, there was never a formula for calculating the rotational period of celestial body derived from their theory.

All the aforementioned theories fail to address the enigma of why celestial bodies rotate, a perpetual mystery that has captivated physicists and astrophysicists alike.

The following segment presents my attempt to elucidate the theory of the rotation of celestial body and derive the formula for calculating the period of rotation of celestial bodies around their axis.

2. Theory and Equation

Massive celestial bodies tend to assume a spherical shape. According to the gravity defined, the gravity on the surface of a rotational spherical body is a net acceleration that impart on the object and equal to the difference between the centripetal acceleration coming from its mass or mass distribution and the centrifugal acceleration coming from its rotation [2].

The modern classical physics tell us that the rotated object constitutes a rotating reference frame around its axis and the strength and direction of the local "gravity" at any point on the body's surface is actually a combination of gravitational and centrifugal forces.

The centripetal acceleration (a_p), the true gravitational acceleration, pointing directly toward the center of the celestial body and coming from mass or mass distribution, may be calculated by the following equation:

$$a_p = \frac{Gm}{r^2} \quad (1)$$

Here,m represents the total mass of a celestial body and r is its average radius. G is gravitational constant.

Let the non-rotating inertial frame be one whose origin lies at the center of the celestial body and the rotating frame be one whose origin is fixed with respect to some point, of latitude θ , on the celestial body's surface with an angular velocity vector (ω). The angular vector points from the center of the rotational body toward its pole. The displacement vector of the origin of the rotating frame with respect to the center of celestial body is approximately equal to its radius r. The centrifugal acceleration (a_f) coming from the rotation is a apparent acceleration felt by an object moving in a circular path observed from a rotating reference frame. The magnitude of centrifugal acceleration on an object' surface with mass m can be calculated by the following equation.

$$a_f = \omega^2 r\cos\theta \quad (2)$$

Taking celestial body be a sphere, its average radius is the same as at equator. The magnitude of centrifugal acceleration varies with latitude at celestial body's surface. Taking 45 degree of latitude at the surface of celestial body as a average displacement, the average centrifugal acceleration, a_f, may be calculated by the following equation:

$$a_f = \omega^2 r\cos 45 = \frac{4\pi^2}{t^2} r\, 0.70710678118655 \cong \frac{2.83\pi^2 r}{t^2} \quad (3)$$

Here, ω represents the angular velocity of a celestial body. The symbol t is its average rotational period, r its average radius and θ signifies a point-displacement of latitude at the surface of celestial body.

The gravitational acceleration g in a local point closing to the celestial body's surface has two components: one is the true gravitational acceleration which always points directly toward the center of the celestial body and another is the so-called centrifugal acceleration that is normal to the celestial body axis of rotation and directed radially away from the axis of rotation.

According to Bernhard Hofmann-Wellenhof's definition and classical physics, the (average) gravity(g) on the surface of a rotational celestial body may be calculated by the following equation without considering angular deviation.

$$g = a_p - a_f = \frac{Gm}{r^2} - \frac{2.83\pi^2 r}{t^2} \quad \text{or} \quad g = \frac{Gmt^2 - 2.83\pi^2 r^3}{r^2 t^2} \quad (4)$$

So, a formula for calculating the (average) rotational period of a rotational celestial body is born as following:

$$t^2 = \frac{2.83\pi^2 r^3}{Gm - gr^2} \quad (5)$$

Here, t represents the average rotational period (sidereal) of a celestial body that rotates around its axis. r is its average radius, g the (average) surface gravity on it and m its mass. G is a gravitational constant.

This formula may be called rotational period formula of celestial body.

According to the Schwarzschild definition, the size of a black hole or its radius (r) can be described by the following equation:

$$r = \frac{2Gm}{c^2} \quad (6)$$

Then, the formula for calculating the rotational period (t_B) of black hole may be written as following form: or

$$t_B{}^2 = \frac{2.83\,\pi^2\left(\frac{2Gm}{c^2}\right)^3}{Gm - g\left(\frac{2Gm}{c^2}\right)^2} = \frac{22.64\pi^2 (Gm)^3}{c^6} \quad \frac{c^4}{Gmc^4 - 4g(Gm)^2} \quad = \frac{22.64\,\pi^2 (Gm)^2}{c^2(c^4 - 4gGm)} \tag{7}$$

$$t_B{}^2 = \frac{22.64\pi^2 (Gm)^2}{c^2(c^4 - 4gGm)} \qquad \text{or} \qquad t_B{}^2 = \frac{22.64\pi^2 (Gm)^2}{c^6 - 4gc^2 Gm}$$

The magnitude of the term, $c^4 - 4gGm$, must exceed zero, denoted as ($c^4 - 4gGm \nleq 0$ or $c^4 > 4gGm$). So, the gravity (g_C) calculated by $\frac{c^4}{4Gm}$ and called critical value of gravity on the surface of black hole can be expressed by the subsequent equation:

$$g_C = \frac{c^4}{4Gm} \tag{8}$$

The value of gravity (g) on the surface of black hole can not be bigger than its critical value $\left(g < g_C \text{ or } g < \frac{c^4}{4Gm}\right)$.This is a principle called gravity principle of Black hole.

Let's write Equation 7 as follows to calculated the surface gravity of black hole.

$$g = \frac{c^6 t_B{}^2 - 22.64\pi^2 (Gm)^2}{4\, t_B{}^2 c^2 Gm} \tag{9}$$

Therefore, $c^6 \nleq 4gc^2\, Gm$ in 7. The value of c^6 $\left(299792458\,\frac{\mathrm{m}}{\mathrm{s}}\right)^6$ is equal to 7.2597926626746E+50 $\left(\frac{m}{s}\right)^6$. No matter how massive the black hole is, the value of c^6 must always be more greater than that of $4gc^2\, Gm$. So, Comparing the value of c^6 to that of $4gc^2$ Gm, the value of $4gc^2\, Gm$ is too small to be negligible. So, the rotational period (t_B) of black hole can be calculated by the following equation:

$$t_B{}^2 = \frac{22.64\pi^2 (Gm)^2}{c^6} \tag{10}$$

The formula 10 for calculating the rotational period of black hole may be also written as the following form:

$$\frac{\mathrm{m}}{t_B} = 2.7007390051847\text{E}{+}34\,\frac{kg}{s} \quad \text{or} \quad \frac{\mathrm{m}}{t_B} = 2.7\text{E}{+}34\,\frac{kg}{s} \quad \text{or} \quad t_B = \frac{\mathrm{m}}{2.7\text{E}{+}34} \tag{11}$$

In a word, for black hole, the ratio of mass to rotational period is a constant ($2.7\text{E}{+}34\,\frac{kg}{s}$) which may be referred to as black-hole constant.

Massive celestial bodies typically adopt a spherical shape due to the gravitational field they generate. This field creates a gravitational spherical space with a central focal point, around which the celestial body rotates.

The orientation of this axis, in relation to the celestial sphere, is either directed upward or downward. The axis can be referred to as the gravitational spherical space axis, or more succinctly, the axis of spherical-space. The space itself can be termed axial spherical space. Within this spherical domain, the movement of all objects must adhere to the curvature of the space around its central point and axis. This is a fundamental principle known as the motion principle of celestial bodies in axial spherical-space.

So, there are only two forms of motion for the celestial body in an axial spherical-space: one is rotation (spin) motion and the other is orbital motion.

Obviously, the rotation and orbital motion of celestial body are all a representation of curvature space.
The orientation of the axis of spherical-space can be ascertained by applying the right-hand rule: the thumb points towards the direction of the axis and the finger the rotational direction of celestial body.

Referring the celestial sphere, the axis direction of spherical space with different celestial body may be up or down.

3. Result

It is assumed that the surface gravity (*g*), radius(*r*) and mass (*m*) of planet and the sun are known quantities showed in table 1 from [3-6]. Then, their rotation period (*t*) can be accurately calculated by the formula 5. The value of the rotational period of planet and the Sun calculated by the formula 5 in table 1, including dwarf planets and Halley's Comet in table 2, is almost the same as the value in the literature.

It can be also assumed that the rotational period (*t*), radius(*r*) and mass (*m*) are known quantities. Then, the average value of surface gravity (*g*) can be accurately calculated by the formula 4 in table 1,2 and 3.

	Mercury	Venus	Earth	Mas	Jupiter	Saturn	Urania	Neptune	Sun
r (m)	2.4397 e + 6	6.0518e+6	6.371e+6	3.3895e+6	6.9911e+7	5.8232e+7	2.5362e+7	2.4622e+7	6.96342e+8
M (kg)	3.3011e+23	4.8675e+24	5.97237e+24	6.4171e+23	1.8982e+27	5.6834e+26	8.6813e+25	1.02413e+26	1.9885e+30
Gm $\left(\frac{m^3}{s^{-2}}\right)$	2.20318055e+13	3.24860844e+14	3.9860075e+14	4.28282388Ee+13	1.26686739e+17	3.7931466e+16	5.79396907e+15	6.83512555e+15	1.32714081e+20
2.83 $\pi^2 r^3$	4.05597677e+20	6.21257703e+21	7.22285666e+21	1.0876598e+21	9.54383064e+24	5.51532742e+24	4.55655562e+23	4.16923295e+23	9.43091765e+27
r^2g $\left(\frac{m^3}{s^{-2}}\right)$	2.20317897e+13	3.2486083e+14	3.97627878e+14	4.26898254e+13	1.19208502e+17	3.41051431e+16	5.6757365e+15	6.71099944e+15	1.32712068e+20
Gm_e $\left(\frac{m^3}{s^{-2}}\right)$	1.58e+7	1.4e+7	9.72872e+11	1.384134e+11	7.474101e+15	3.8263229e+15	1.1823257e+14	1.2412611e+14	2.013e+15
t(s)	5.06662995e+6	2.1065505e+7	8.61641575e+4	8.86456584e+4	3.573402e+4	3.796599982e+4	6.20797234e+4	5.7955747e+4	2.16448754E+6
$t_o(s)$	5.0670144E+6	2.09971526E+7	8.616416E+4	8.86426848E+4	**3.573e+4**	3.7966e+4	6.2063712e+4	5.795574653e+4	2.16424158e+6
*	99.99 %	100.32 %	100 %	100%	100%	100%	100.%	100%	100%
g $\frac{m}{s^2}$	3.70149294	8.87009387	9.7962896	3.7158066	24.39024718	10.05764874	8.8236891	11.06981973	273.69397312

g_o $\frac{m}{s^2}$	3.7	8.87	9.80665 9.806782296018 9	3.72076	24.79	10.44	8.69	11.15	274
*	100 %	100 %	99.89%	99.87%	98.39%	96.34%	101.54%	99.28%	99.89%

Note: * symbol represents the ratio of t and t_o (Sidereal time) and g and g_o. G=6.67408e-11m^3•s^{-2}•kg^{-1}.light speed: c=299792458(m/s)

Table 1: The Observed Data of Planet and Sun in Literature: Mass(m), Average Radius(r) , Rotational Period(Sidereal) (t_o) and Gravity (g_0). The Effective Mass(Gm_e), No-Effective Mass(r^2 g). Rotational Period (t) and g Calculated by Formulas

	Ceres	Haumea	Makemake	Eris	Halley	Pluto	Quaoar	Gonggong	Sedna
r (m)	4.697e+5	7.8e+5	7.15e+5	1.163e+6	1.1e+4	1.187e+6	4.45e+5	6.15e+5	-
M (kg)	9.3839e+20	4.006e+21	3.1e+21	1.6466e+22	2.2e+14	1.303e+22	1.20e+21	1.75e+21	-
Gm $\left(\frac{m^3}{s^{-2}}\right)$	6.26288993e+10	2.67363644e+11	2.0689648e+11	1.09895401e+12	14682.976	8.69632624e+11	8.008896e+10	1.167964e+11	-
2.83 $\pi^2 r^3$	2.89432877e+18	1.32547026e+19	1.02094961e+19	4.39364866e+19	3.7176135e+13	4.67130622e+19	2.46130942E+18	6.4933690432947E+18	-
r^2g $\left(\frac{m^3}{s^{-2}}\right)$	5.99166544e+10	2.00648e+11	2.05384603e+11	1.098930391e+12	1.36538104e+4	8.69415833E+11	7.9481307e+10	1.16352733e+11	-
Gm_e $\left(\frac{m^3}{s^{-2}}\right)$	2.7122449e+9	6.6715644e+10	1.511877e+9	2.3619e+7	1029.1656	2.16791E+8	6.07653e+8	4.43667e+8	-
t(s)	3.26670171e+4	1.40951971e+4	8.21757968e+4	1.36389805e+6	1.90059458E+5	5.5186814E+5	6.364368e+4	1.20978022e+5	-
t_o(s)	3.2667012e+4	1.4095229e+4	8.217576e+4	1.3639104e+6	1.9005946e+5	5.51867793e+5	6.364368e+4	1.20978e+5	3.69828e+4
*	100 %	100 %	100 %	100%	100%	100%	100%	100%	-

g $\frac{m}{s^2}$	0.27158541	0.32979668	0.40174992	0.8124764	0.00011284	0.61710318	0.401370064	0.30762835	-
g_o $\frac{m}{s^2}$	0.284 (at equatorial)	0.24 (at longest axis)	0.57(at equatorial)	0.8220559	-	0.620	At pole:0.31 At equator:0.16	0.18 (at equatorial)	-

Note: * symbol represents the ratio of t and t_o(Sidereal time)

Table 2: The Observed Data of Dwarf Planet and Halley in Literature: Mass(m), Average Radius(r), Rotational Period (Sidereal) (t_o) and Gravity (g_0). The Effective Mass(Gm_e), No-Effective Mass($r^2 g$), Rotational Period (Sidereal)(t) and Gravity (g) Calculated by Formulas

The average gravity on the surface of 5 neutron stars is equal to 1.53230651e+12 $\frac{m}{s^2}$ calculated by 3 in table 3 based on DATA from [4]. This value is fully consistent with [7].

	PSR J1748-2446ad	XTE J 1739-285	PSR B1919+21	PSR B1913+16	PSR J0348+0432
r (m)	16000	10900	1.4e-5R⊙ 9737	1.4e-5R⊙ 9737	13000
m (kg) and Gm	< 2⊙ 2.65428162E+20	1.51⊙ 1.990711215E+20	1.4⊙ 1.857997134E+20	1.441⊙ 1.91240990721E+20	2.01⊙ 2.6675530281E+20
t (s)	1.395954824445e-3	8.99280576e-4	1.3373	0.05902999792988	0.039122656917806
Gmt^2	5.17237171e+14	1.60989922e+14	3.32278873e+20	6.66387007e+17	4.08290941e+17
$2.83\pi^2r^3$	1.14405296e+14	3.61714297e+13	2.57846767e+13	2.57846767e+13	6.13643641e+13
r^2t^2	498.864607	96.08230682	1.6955399 6e+8	3.303664 04e+5	2.58668406e+5
g $\left(\frac{m}{s^2}\right)$	8.07497404e+11	1.29907885e+12	1.95972289e+12	2.01703688e+12	1.57819651e+12

Note: ⊙. the Sun's mass :1.9885e+30kg and its Gm=1.32714081e+20 R⊙=6.955e+8m

Table 3: The gravity on the surface of pulsar neutron star calculated by formula: $g = \frac{Gmt^2 - 2.83\,\pi^2 r^3}{r^2t^2}$. r(radius), m(mass) and t (rotational period) come from data in literature. g is calculated by formula

The new date shows that the mass of Sagittarius A that is a black hole at the center in the Milk-Way system is equal to 8.5445845E+36kg (Gm=5.702724051976E+26) from [4,8]. The gravity on the surface of this black hole can not be bigger than 3.54e+6 $\frac{m}{s^2}$ $\left(\frac{c^4}{4Gm} = \frac{8.0776087130625E+33}{4\times 5.702724051976E+26}\right.$=3.54111852e+6). Its rotational period calculated by 10 or 11 is equal to 317 seconds (t_B=316.37949774475≈ 317s).

The critical gravity on the surface of the black hole of GRS 1915+105 is equal 1.227e+12$\frac{m}{s^2}$ (1.2271118e+12) calculated by 8 based on its mass is 12.4$M_\odot$ or 2.46574E+31kg from [7].

The rotational period of the black hole in GRS 1915+105 calculated by 10 or 11 is equal to 0.00091298714732021s or 0.000913s i.e. it rotates at least 950 times per second.

In the realm of spherical gravitational-space, the colossal entity situated at the spatial core is referred to as the parent or primary star. Objects with low masses can be called child or second stars in it.

According to the principle of celestial body's motion in axial spherical-space, the primary star undergoes rotation around both its axis and center. The object with less mass, such as a planet in the solar system or a star in the Milky Way, moves around the center and axis along the curvature of spherical gravitational space. This motion is known as orbital motion.

In the solar system, according to the above motion principle of celestial body, the planets always orbit on or near the celestial equator.

There are only two types of motion in a spherical gravitational field. If an object does not achieve orbital motion, it will inevitably fall towards the central object.

Assuming the direction of the spherical-space axis is upwards with respect to the celestial sphere, then the direction of the celestial body's spin is counter-clockwise. Conversely, if the direction of the spherical-space axis is downwards with respect to the celestial sphere, the celestial body's spin is clockwise. This explains why Venus exhibits a clockwise rotation.

The gravitational field, or gravitational spherical-space, of an atom results from the interaction between positive and negative charges. This spherical gravitational field also has a axis. Thus, the space within an atom is an axial spherical-space, commonly referred to by physicists as a magnetic field. Regarding the orientation of the atom's axis within spherical space, if one end of the axis is designated as the South Pole, then the opposite end is designated as the North Pole. This is why magnetic fields have both a South Pole and a North Pole. Since the spherical space and its axis form a unified entity, they cannot be divided, yet their directional nature remains indivisible. Consequently, the north and south poles are inherently inseparable, and a magnetic field can never exist with only a single pole.

When an electron jumps from a high-energy orbit to a low-energy orbit, it results in an oscillation of the electric field. This oscillation causes the atom's gravitational spherical space or magnetic field to oscillate, thereby generating light or electromagnetic waves. Light is, in fact, an atomic gravitational wave.

If a particle in the micro-physical world, for example, an atom, electron, photon, etc., manifests spin motion with a specific spin direction, its space belongs to axial spherical space.

4. Discussion

The equation involving 4 and 5 reveals a constant physical and mathematical relationship among the average surface gravity, average rotational period (sidereal), mass, and average radius for a spherical object that rotates around its axis. The equation contains four variables. Therefore, knowing the values of three variables allows you to calculate the value of the fourth.

The theory of motion for celestial bodies within an axial spherical- space does not contravene Newton's theory of universal gravitation, nor does it conflict with Einstein's theory of relativity or the concept of uneven curvature of space.

Essentially, this theory aligns with and complements those of Newton and Einstein. However, it is not sufficient to simply state that space is curved, as Einstein did. All celestial bodies including microscopic particles are an axial spherical space. This axial spherical space acts as an energy pack, where the density of the energy decreases as the radius increases.

Moreover, this doctrine elucidates numerous phenomena that modern physics and astrophysics cannot explain, such as the spin and spin direction of celestial bodies and particles, the distribution of planets in the solar system, the polarity of magnetic fields, and the inseparability of magnetic poles, as well as the nature of light.

The essence of rotation (spin) and orbital motion is the same. Both are manifestations of curvature space.

The orbital motion of celestial bodies can be described by Newton's law of gravitation and Kepler's laws for calculating orbital periods. For the first time in the 500-year history of astrophysics, there is a formula to describe the rotational motion of celestial bodies, including black holes. These are formula 5 for calculating the rotational period of ordinary celestial bodies and formula 10 or 11 specifically for black holes.

Whether the calculation results are consistent with observations is the sole criterion for testing physical theories and formulas. The formulas presented in this article, derived from Newton's and Einstein's theories, including the Schwarzschild radius, embody a concise, precise, and definitive nature.

If the mass represented by the term of $Gm - gr^2$ is called effective rotational mass (m_e) ($Gm_e = Gm - gr^2$) , the mass represented by the term of gr^2 may be called no-effective rotational mass. The no-effective mass does not mean that there is a loss of the rotational mass due to centrifugal acceleration caused by the rotation.

The average surface gravity and the average rotational period of the planet, the Sun, neutron stars, dwarf planets, and Halley's Comet, calculated using equations 4 and 5, are totally identical to the values found in the literature data presented in tables 1, 2, and 3. These results validate the theory and formulas presented in this article as correct and reliable.

Although gaseous objects with asymmetrical shapes exhibit different rotational periods in various regions, they as a whole have their own inherent average rotational periods. The rotational period, surface gravity, radius, and mass detailed in this article represent their average values.

In the solar system, Venus has the smallest effective rotational mass, which is why it has the longest rotational period. Because its axial tilt is downward relative to the celestial sphere, its rotation is clockwise.

Because the effective rotational mass of the Sun (2.013E+15kg) is smaller than that of the Jupiter (7.474101e+15kg) and Saturn (3.8263229e+15E+15kg), the rotational period of Sun is bigger than that of Jupiter and Saturn.

The average surface gravity of a neutron star is approximately 2×10^11 times stronger than that of Earth, at around 2.0×10^12 m/s². The surface gravity of neutron stars, as calculated by formula 4, is almost entirely consistent with the data presented in the aforementioned literature. This further validates that theories and formulas 4 and 5 are correct and reliable.

The rotational period of the black hole in GRS 1915+105, calculated to be approximately 0.000913 (0.00091298714869607) seconds, indicates that it rotates 1095 (1095.3056693385) times per second. If the mass of the black hole in GRS 1915+105 is 12.4 solar masses (2.46574 x 10^31 kg), then its frequency (f) is approximately 1095 Hz. This result is close to the theoretical upper limit for its rotation, which is 1,150 spins per second [9,10].

If the mass of black hole in GRS 1915+105 is equal to 14.4 $M_\odot$ (2,86344E+31kg) from, its rotational period was equal to 0.0010602431404213s [11]. So, it rotates 943 (943.17988193033) times per second $\left(f = \frac{1}{t_B} \approx 943\right)$. This result is almost fully consistent with the observation value that is 950 times per second [10].

There is a principle: $t_B^2 c^6 \neq 22.64\pi^2 (Gm)^2$. If two values are equal ($t_B^2 c^6 = 22.64\pi^2 (Gm)^2$), it would result in the numerator of Equation 9 being zero. In other words, the value of $t_B^2 c^6$ must be greater than that of $22.64\pi^2 (Gm)^2$. Thus, an integer principle of Equation 10 is established: If the calculated value (t_B) exceeds 1, the integer part that must be added 1 as the result of calculation. For example, the rotational period of Sagittarius A calculated by 10 or 11 is equal to 316.37949774475s and its integer is equal to 316s. The value of integer adds 1 equal to 317s (t_B = 316.37949774475≈ 317s). So, the rotational period of Sagittarius A is equal to 317s as the result calculated by 10.

Conversely, if the value is less than 1, the integer part of its derivative $\left(f = \frac{1}{t_B}\right)$ shall serve as the calculated result. For example, the value of f for the black hole with mass 12.4 $M_\odot$ is equal to 1095.3056693385 and then integer 1095 times per second as a calculated result. Then, its surface gravity $\left(g = \frac{c^6\left(\frac{1}{1095}\right)^2 - 22.64\pi^2(1.64565460192E+21)^2}{4\left(\frac{1}{1095}\right)^2 c^2 1.64565460192E+21}\right)$ is equal to 6.8481365136909e+8$\frac{kg}{s^2}$ (less than critical gravity:1.2271118e+12$\frac{m}{s^2}$).

The rotational period of Sagittarius A is equal to 317s as a calculated result. Then, its surface gravity $\left(g = \frac{c^6(317)^2 - 22.64\pi^2(5.702724051976E+26)^2}{4\,(317)^2 c^2 5.702724051976E+26}\right)$ is equal to 1.385e+4$\frac{kg}{s^2}$ (1.3849347244408e+4$\frac{kg}{s^2}$) (less than critical gravity: 3.54111852e+6$\frac{m}{s^2}$).

Above small discrepancy serves as further evidence that the formula for calculating the rotational period of a black hole is accurate.

The observed data for the black hole GRS 1915+105 include both mass values and spin frequencies. Consequently, the results of the calculations for the black hole in GRS 1915+105 can serve as a litmus test to verify whether the theory and formulas presented in this paper are correct.

The rotational linear speed of black hole is a constant and equal to 2.52024338e+8 $\frac{m}{s}$ $\left(v = \omega r = \frac{2\pi r}{t} = \frac{2\pi\frac{2Gm}{c^2}}{\frac{m}{2.7007390051847E+34}} = \frac{4\pi G 2.7007390051847E+34}{c^2}\right)$. It is a constant and remarkably close to the speed of light, yet slightly below it. As long as celestial body is a black hole, its spin linear velocity remains constant. This constant is independent of the black hole's mass.

From the stars or the Sun to planets, from dwarf planets to comets, and from neutron stars to black holes, the calculated values of rotational periods and surface gravity for all known celestial bodies align with observations in the literature. This fully demonstrates that the theory and its formulas presented in this article are correct and reliable.

The formula $g_c = \frac{c^4}{4Gm}$ for calculating the critical gravity at the surface of black hole based on Newton's mechanism is the same as the formula $k = \frac{c^4}{4Gm}$ (with mass M is k = $\frac{1}{4M}$ and k = $\frac{c^4}{4Gm}$ in SI units) based on Schwarzschild solution with Einstein's theory of relativity [12]. Here, k is surface gravity on black hole. m is its mass and c light speed . So, $g_c = k = \frac{c^4}{4Gm}$.

It can be seen that Newton's mechanism and Einstein's theory of relativity are in harmony with each other. This is the theoretical significance of this article.

The surface gravity on black hole can only be less than $\frac{c^4}{4Gm}\left(g < \frac{c^4}{4Gm}\right)$, not equal to $\frac{c^4}{4Gm}\left(g \neq \frac{c^4}{4Gm}\right)$. If it is equal to $\frac{c^4}{4Gm}$, the denominator of Equation 7 $\left({t_B}^2 = \frac{22.64\pi^2(Gm)^2}{c^6 - 4gc^2Gm}\right)$ will be to zero.

The gravity on the surface of a black hole is not infinite and is less than its critical gravity. The gravitational pull on the surface of a black hole is inversely proportional to its mass; the greater the mass, the weaker the surface gravity, and vice versa. This view is proved by black hole jets.

In astronomy, rotation is a commonly observed phenomenon. All celestial objects, such as planets, stars, black holes, and even particles and nuclei, rotate around their axes. Each rotating body possesses angular momentum.

The effective rotational mass m_e (Gm_e) for black hole may be expressed by the term of (c^6 - 4$gGmc^2$).

There are two variables in formulas 7 concerning black holes. Once the mass of a black hole is ascertained, its rotational period can be computed using the formula 10 or 11 $\left(t_{LB} = \frac{m}{2.7007390051846E+34}\right)$.

All celestial bodies must maintain a specific physical-mathematical relationship among their four celestial bodies factors. The change of any one factor will inevitably lead to the corresponding coordinated change of the other three factors.

According to modern astrophysics, the orbital period or rotation period of planets, stars, and black holes is determined by the angular momentum resulting from their innate formation process.

Angular momentum inherently includes a temporal element, such as spin frequency or rotational period. Determining the rotation period of a celestial body is crucial to the disciplines of physics and astrophysics. The examination of the rotational cycles of celestial bodies is fundamental to achieving a comprehensive understanding of physics.

Physical theories should be able to explain the orbital and rotational dynamics of celestial bodies. The theories and formulas in this paper are of central significance in the field of physics.

Provided that angular momentum is conserved, the mathematical relationship corresponding to the aforementioned four factors will remain unchanged.

Throughout history, all entities have undergone transformations. Celestial bodies also evolve over time. The size, mass, circumference, orbital period, and rotation period of any celestial body will change throughout its evolution. However, these changes are very slow compared to today's observations. Nonetheless, the laws of physics are unchanging despite the evolution of celestial bodies.

The axial spherical space has four distinct characteristics: firstly, it has a directional spin axis; secondly, two axial spherical spaces attract each other because their curvature is in opposite directions; thirdly, it rotates around this axis; and fourthly, it serves as an energy package or energy field with an energy center. The energy density is highest at its center and gradually decreases with increasing radius.

All particles that spin around their axis belong to axis spherical-space. If the electron is an axial spherical space, it must have an energy center with high energy density. In other words, it must rotate around its axis and have its own energy field. The same goes for photons. It is not difficult to understand why the particles are entangled with each other.

The theory of axial spherical-space not only answers all the difficult questions of modern physics but also unifies Newton's theory of gravitational fields, Einstein's theory of space bending and Quantum physics one comprehensive theory [13].

5. Conclusion

A consistent physical and mathematical relationship exists among the average rotational period, average surface gravity, total mass, and average radius of a celestial body. The rotational period of a celestial body that rotates around its axis is directly proportional to the cube of its radius and inversely proportional to its mass or effective mass. The essence of rotation and orbital motion is identical; both are manifestations of axial spherical-space.

For black holes, the ratio of mass to rotational period is a constant, as does the spin linear velocity.

Data Availability Statements

The datasets used and/or analyzed during the current study are available from the corresponding authors and their published article.

Statement and Declaration

I have not a funding and competing interests.

Ethics, Consent to Participate, and Consent to Publish declarations

Not Applicable.

Clinical Trial Number

Not Applicable.

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