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A new model for describing black holes based on the essential relationship between electric field and gravitational field analysis

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Abstract: Einstein aimed to find a unified theoretical model to explain various interactions in nature, and the relationship between gravitational and electric fields was particularly important. For the first time, this paper provides the internal relationship equations of the electric and magnetic fields. Further, the relationship between the magnetic and gravity fields is analyzed, and the relationship equations of the electric, magnetic, and gravity fields are established. On this basis, a general formula for calculating the radius of charged particles is derived. Simultaneously, we also discussed and made predictions on black holes, providing convenience for future research and experimental detection.
Keywords: new model, electric field, gravitational field, black hole

Introduction

In 1921, in *A Brief Outline of the Development of the Theory of Relativity*, Einstein raised whether electric and gravitational fields could be described in a unified form (Einstein,1921).

Due to the continued efforts of the Chinese physicist Zhao Zhong-Yao and the American physicist Anderson, it was found that γ rays with energies greater than twice the static mass energy of electrons ($2\ m0c^2$ = 1.02 MeV) produced positive and negative electron pairs (Zhang,1987) near the positively charged heavy nucleus. Therefore, positive and negative electrons should be considered products of unique electromagnetic processes. Meanwhile, energetic positive and negative electrons accelerated to near the speed of light can produce positive and negative proton pairs and other particles in collisions. Similarly, positive and negative proton pairs and other particles can be regarded as products of another unique electromagnetic process. Therefore, the essential relationship between positive and negative electrons, positive and negative protons, and other particles, such as energy, mass, and charge, can be described using Maxwell's equations, which reveal the basic laws and set the major results of electromagnetism.

Theory

1. Relationship between electric and magnetic fields from charge

According to the principle of electromagnetism, the magnetic field has the characteristics of spin without a

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source (Zhang and Qi,1997), meaning that the magnetic field of the electron and proton can exist independently without dependence on other things. The relationship between the electric and magnetic fields of the electron and proton bodies can be derived from Maxwell's equations (Zhang and Qi,1997; Ding,2017), which could be written as

$$E = B \cdot C, \tag{1}$$

where ***E*** is the electric field intensity at the radius r of the electron and proton bodies, ***B*** is the corresponding magnetic induction intensity, and ***C*** is the speed of light.

The formula shows that the essence of charge is that the eddy magnetic field ***B*** moving at the speed of light must generate electric field ***E***, and the electric field intensity ***E*** equals the magnetic induction intensity ***B*** multiplied by the speed of light **C**. A rotating magnetic field is more fundamental than electric charges and fields at the ultimate level. This independent magnetic field rotates at the speed of light.

The essence of the electron and proton energy is the electric field energy in the electric field induced by the vortex magnetic field, which is manifested as the electric field energy around the body radius of electrons and protons. The expression in the integral form is

$$mc^2 = -\oiint_S \frac{1}{2}\varepsilon E^2 dS \int_{r_0}^{\infty} dr, \tag{2}$$

In the formula, the left side is the mass energy of an electron or proton (***E*** is sometimes used to represent energy in physics, but this article uses ***E*** to represent the electric field strength according to the electromagnetic convention). ***S*** is the surface area of a stable particle sphere, such as electrons and protons, and ***r*** is the radius of a particle sphere (Zhang and Qi,1997; Ding,2017).

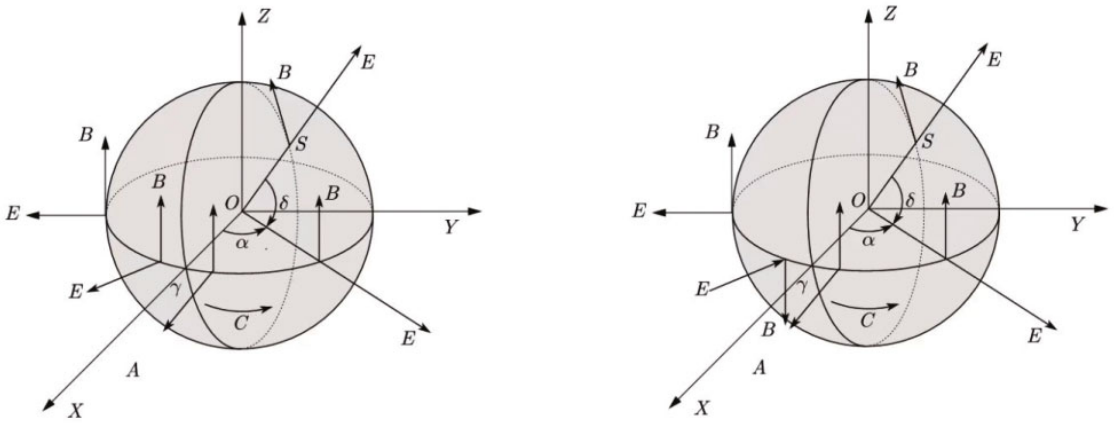

FIG. 1 Magnetic and electric field intrinsic relationship of (left picture) positrons and protons and (right picture) electrons and antiprotons.

2. Relationship between magnetic and gravitational fields from charge

Einstein highlighted that "the elementary particles of matter are, by their very nature, nothing more than the condensation of electromagnetic fields" (Einstein,2018).

By combining analytical Formulas 1 and 2, the formula for the source of the mass of an electron and proton can be obtained as follows:

$$m = -\oiint_S \frac{1}{2}\varepsilon B^2 dS \int_{r_0}^{\infty} dr, \tag{3}$$

m on the left side of the formula corresponds to particle mass. The right side of the formula reflects that the mass of the corresponding particle comes from the vortex magnetic field of the particle body, and the mass of the particle is proportional to the square of magnetic induction intensity ***B*** of the particle body. The mass of the electron and proton corresponds to or essentially comes from the eddy magnetic field of electric charge. The essence of particle inertial mass reflects the overall property of the eddy magnetic field around the radius of the particle body.

From a topological perspective, the field lines of protons and positrons point out from their bodies, whereas those of antiprotons and electrons point out from their bodies. Regardless of protons, positrons, antiprotons, and electrons, the eddy magnetic field lines are perpendicular to the electric field lines and point outside the body. This difference is crucial for the direction of electric and magnetic field lines.

According to the analysis of Einstein's mass-energy

formula, photons have energy and mass and a moving mass but no rest mass; that is, they have no inertial mass. Photon pairs propagate to infinite space at the speed of light and finite energy. Since the finite energy of photons is divided by the infinite volume, the result is zero; therefore, photons have energy and moving mass but no rest mass. When photon pairs are converted into electron pairs, the photons carrying energy exist in the finite space and volume; energy is still conserved, but the rest mass is obtained.

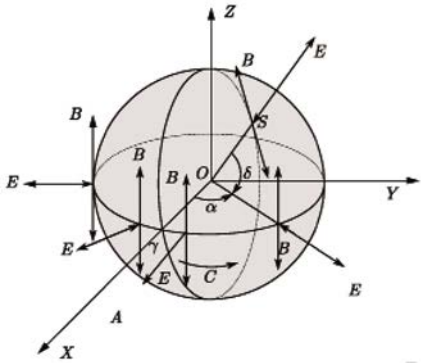

FIG. 2 A diagram of electric and magnetic fields canceling each other when positive and negative electron pairs are converted into gamma photon pairs.

The principle of inertial mass cancelation is when positive and negative electron pairs are converted into gamma photon pairs. The inertial masses cancel each other when the positive and negative electron pairs are converted into gamma photon pairs. The vortex magnetic field representing the inertial mass property of the corresponding photon pair is synchronized everywhere, in opposite directions, and of equal magnitude; thus, they cancel each other out. Therefore, the inertial mass of the photon pair, namely the rest mass, is zero. When the inertial mass is zero, it immediately propagates at the speed of light.

Einstein proposed that matter generates the gravitational field. The inertial mass is the potential energy and is equal to the gravitational mass (Einstein,2018). Similar to how an electric charge produces an electric field, inertial mass produces a gravitational field and can be regarded as a gravitational charge. The gravitational acceleration is equivalent to the intensity of the gravitational field and acceleration. Furthermore, from the viewpoint of inertia, the acceleration of an object is equivalent to the acceleration of gravity and the strength of the gravitational field.

The two properties of a body, inertial and gravitational, are manifestations of different aspects of the same nature. The inertial and gravitational properties of a body derive from the same nature as the body. Einstein used the equivalence of inertial and gravitational masses as the starting point for his general relativity theory. Therefore, from the viewpoint of modern physics, the equivalence between the two is not accidental; it contains profound physical significance.

For a charge moving at a constant velocity, its total energy remains constant, although it carries an electromagnetic field and the energy and momentum of the electromagnetic field, and thus has a net energy flow toward the charge. In other words, the net energy flux of any closed surface is zero. However, for an accelerating charge, the situation differs. The electric and magnetic fields of an accelerating charge are not radial (Zhang and Qi,1997). Figure 3 shows that the electric and magnetic field lines are similar. As the charge accelerates to the right, the left field decreases while the right field increases. Due to acceleration, the increase in the field (corresponding to a new, greater velocity due to acceleration) is greater than the decrease in the preexisting field (corresponding to the earlier smaller velocity). Therefore, the net excess energy must be transferred to the entire space. An accelerating charge requires external energy, thus increasing its own energy and mass.

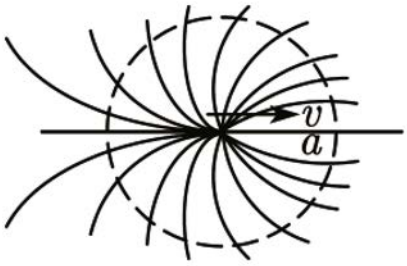

FIG. 3 Changes in electric and magnetic fields caused by accelerating charges.

In summary, the essence of the object acceleration equivalent to the acceleration of gravity and the intensity of the gravitational field is that when the object is accelerating, the bending effect of the magnetic field of the object caused by the acceleration direction a is the same as that caused by the gravity field $\boldsymbol{g}$ in the opposite direction. Acceleration $\boldsymbol{a}$ is equivalent to the acceleration of gravity or the intensity of the gravitational field $\boldsymbol{g}$, and the effect is the same when acceleration $\boldsymbol{a}$ is equivalent to the acceleration of gravity or the intensity of the gravitational field $\boldsymbol{g}$. The difference is that the acceleration the object is subjected to, $\boldsymbol{a}$, is in the

opposite direction to the strength of the gravitational field the object is subjected to, $\boldsymbol{g}$.

Conclusions

3. Universal formula for calculating the radius of charged particles

If the formula of electric field intensity at the body radius is established, the expression is (Zhang and Qi,1997)

$$E = \frac{e}{4\pi\varepsilon r^2}, \tag{4}$$

where the electric quantity corresponding to the electric charge is 1.602×10^{-19}**c** (Zhang and Qi,1997) (this is not the speed of light but the unit of electricity in coulombs).

Equations 4 and 2 are solved simultaneously, but the process is omitted here. The formula for calculating the body radius of all charged particles, including electrons and protons, is

$$r = \frac{e^2}{8\pi\varepsilon mc^2}, \tag{5}$$

where the charge quantity $\boldsymbol{e}$, vacuum permittivity $\boldsymbol{\varepsilon}$, and light speed $\boldsymbol{c}$ are constants. The radius of the particle can be calculated if the particle mass is known.

Combining the analysis of Equations 5, 2, and 1, we can calculate that the radius of an electronic body is $r_e = 1.406 \times 10^{-15}$ m (1.406 fm). The electric field intensity $\boldsymbol{E}$ at the radius of the electron body is 7.284×10^{20} V/m, and the magnetic field induction intensity $\boldsymbol{B}$ is 2.428×10^{12} T.

The proton body radius is $r_p = 0.765 \times 10^{-18}$ m (0.765 am). The electric field intensity $\boldsymbol{E}$ at the proton body radius is 2.462×10^{27} V/m, and the magnetic field induction intensity $\boldsymbol{B}$ is 8.202×10^{18} T.

We regard black holes as charged superparticles and apply the above formula to calculate their radius, electric field intensity at the radius, and magnetic induction intensity at the radius. The reasons are discussed below.

A. Black holes that are both spinning and charged, called Kerer–Newman black holes (Zhao, 2000), are a solution to the field equations of Einstein's general relativity theory and are considered to be the most general steady-state black holes, in other words, the most likely actual form of black holes in the universe. The above formulas describe rotating and charged particles.

B. The radius formula of charged particles obtained in this paper shows that the particle mass is inversely proportional to the particle radius, and the larger the particle mass m is, the smaller the particle radius r. Formally, the formula does not exclude the black hole—as long as its mass is finite, its particle radius can be calculated. The larger the mass of the black hole, the larger the Schwarzschild radius representing the event horizon. However, the smaller the body radius of the black hole, the smaller the radius—a crucial feature of particles.

C. The black hole hairless theorem, proposed by York Wheeler in 1973 and proved by Hawking, Cattell et al. (Bekenstein,1995), proposes that no matter what type of black hole exists, its final properties are determined by only a few physical quantities (mass, angular momentum, and electric charge). These physical quantities are consistent with particle characteristics.

4. Discussion and prediction

Based on the above analysis, we can present our discussion and prediction.

4.1. The particle mass is inversely proportional to the particle radius. The larger the particle mass, the smaller the particle radius $\boldsymbol{r}$. The faster a particle moves, the larger its mass (Carroll, 2014) and the smaller its radius.

For example, as the energy of electrons increases during acceleration, their body radius decreases, and the particle mass is inversely proportional to the body radius. If an electron accelerates to 10,000 times its rest mass energy, its body radius shrinks to one-ten-thousandth of its original radius, and the radius of the electron body is 1.406×10^{-19} m.

4.2. The new calculated result of proton body radius is $r_p = 7.65 \times 10^{-19}$ m (0.765 am). Surprisingly, the calculated result shows that the proton body radius is much smaller than the electron body radius. If you compare the size of the electron body to the Bird's Nest stadium in Beijing, the proton body is approximately the size of a football.

4.3. By extension of the above formula, black holes can be considered superparticles. The solar mass is 1.99×10^{30} kg (Ni et al.,1998), its Schwarzschild radius is approximately 3 km (Ni et al.,1998), and the radius of its body can be calculated as approximately 6.437×10^{-76} m.

A black hole of 100 million times the mass of the sun, for example, will have a mass of 1.99×10^{38} kg, its Schwarzschild radius will be approximately 300 million

km, and its radius will be approximately 6.437×10^{-84} m.

The more massive the black hole, the larger its Schwarzschild radius. However, the smaller the radius of the black hole. Any matter, or even light, entering the black hole within the Schwarzschild radius cannot escape and will travel irreversibly toward the radius. In this process, the object continues to tear apart until it reaches the radius of the black hole body and coalesces into the vortex magnetic field, rotating at the speed of light. Simultaneously, the mass of the black hole increases, the radius decreases, and the angular velocity of the vortex magnetic field accelerates.

Just as the primordial universe can be viewed as a super black hole, it can also be considered a super particle. If the mass of the black hole or primordial universe is finite, the black hole can be described using the parameters calculated from the above formula. In other words, a black hole or primordial universe can be described by parameters such as mass, eddy magnetic field strength, particle radius, and rotational angular frequency. The black hole with a mass of 1.99×10^{38} described above has a body radius of 6.437×10^{-84} m. Similarly, it can be calculated that the electric field intensity $\boldsymbol{E}$ at the radius of the black hole body is 3.475×101^{57} V/m, and the magnetic induction intensity $\boldsymbol{B}$ is 1.158×10^{149} T.

4.4. When the body radius of a Kerer–Newman black hole is 6.437×10^{-84} m, the vortex magnetic field at the body radius rotates at the speed of light and generates a strong electric field. From the definition of angular frequency, the angular frequency of the vortex magnetic field at the radius of the black hole body rotating at the speed of light is $\boldsymbol{\omega = C/r}$, where $\boldsymbol{\omega}$ is the angular frequency, $\boldsymbol{C}$ is the speed of light, and $\boldsymbol{r}$ is the black hole body radius. By substituting the black hole body radius value, the rotation angular frequency of the vortex magnetic field at the black hole body radius is 4.66×10^{91} rad/s.

A Kerer–Newman black hole has a singular ring with a specific radius where spacetime is so strange that no spacecraft can reach it; only light can. If the spacecraft must reach the singular ring, its acceleration must be increased to infinity at the singular ring, the rest mass will be reduced to zero, and the spacecraft will be transformed into a photon, fully merging with the black hole at the singular ring (Zhao, 2000).

The characteristics of the black hole singular ring correlate with that of the light speed vortex magnetic field at the radius of the black hole body. Therefore, the ring surrounded by the black hole body radius is the black hole singular ring. Within the black hole singular ring, or the black hole radius itself, neither spacecraft nor light can reach it, and there is no matter, time, or space.

4.5. Planck's constant (Ni et al.,1998) reflects the law of conservation of angular momentum in the microscopic world. The angular momentum of an electron or proton is conserved regardless of whether the radius of its spin body changes. Second, the de Broglie wavelength of the spin of the electron or proton is the circumference of the spin of the electron or proton. Third, electrons and protons can be regarded as converted from photon pairs of corresponding energy. The spin angular momentum of electrons or protons comes from the photon pairs of their past lives. Fourth, whether it is a photon pair, a positive or negative electron pair, or a positive or negative proton pair, its spin angular momentum is a conserved quantity, and its value equals Planck's constant. The spin quantum number of a single positive or negative electron and a single positive or negative proton is 1/2. When two positive and negative particles annihilate into a photon pair, the spin quantum number of the photon pair is 1, which is equal to the sum of the spin quantum numbers of the positive and negative particles. Fifth, there is an inverse relationship between the mass, velocity, and radius of the electron and proton in spin; the larger the particle mass, the faster the speed, and the smaller the spin radius of the electron or proton.

4.6. A neutron is a compound particle comprising an electron and a proton. The shell of a neutron is an electron body (the quantized eddy magnetic field body), and the neutron body radius equals the electron body radius of 1.406×10^{-15} m.

Inside the neutron is a proton body (body radius 7.65×10^{-19} m) moving in a circle at a quarter of the speed of light with a radius of 0.84×10^{-15} m (a circumference equal to the de Broglie wavelength of the moving proton). Therefore, the neutron body radius equals the electron body radius.

4.7. It can be predicted that in a deep inelastic collision experiment with neutrons, the incident particle will first encounter the negatively charged neutron shell, the middle layer will have a positive charge, and when it flies out of the neutron, it will again encounter the negatively charged neutron shell.

4.8. The spin radius of the electron or proton spin body takes a series of discrete values according to different spin velocities. The narrow sense of a proton refers to a radius of 0.765×10^{-18} m (0.765 am) with a

unit positive charge proton body. The general sense of a proton is the proton body at the speed of light 1/4, 1/9, 1/16, 1/25, 1/36, 1/49, 1/64, 1/81 (Zhou,1999) spin body.

4.9. The proton body inherits the spin angular momentum of the previous life photon. Simultaneously, the magnetic induction intensity at the proton body radius is so strong that the proton body in spin motion is affected by the Lorentz force just as it moves in a strong magnetic field. Therefore, the proton body forms a proton spin body around a specific spin radius, similar to the principle that charged particles move at high speeds in the strong magnetic field of the cyclotron, creating a Lorentz force, and the charged particles move in a circle (Zhang,1987).

4.10. The spin motion of the electron or proton body under the action of its own magnetic field indicates that if the electron and proton are compared to the present life and the photon to the past life, the electron and proton body in the present life will move in a circle around the shadow of the photon in the past life consciously in addition to the rotating motion with the internal vortex magnetic field. Corresponding to this motion is the spin velocity, spin radius, and spin angular momentum of the electron and proton. The spin angular momentum and spin magnetic moment of electrons and protons cannot be understood as electrons and protons rotating around their own axes but should be understood as a circular rotation, thus forming a ring current and a spin magnetic moment (Zhang and Qi,1997).

4.11. The proton magnetic moment ***ml*** originates from the equivalent toroidal current ***i*** caused by the proton spin body. Regardless of whether the proton spin velocity changes, the proton magnetic moment ***ml*** is conserved, and the electron magnetic moment is 1836 times that of the proton magnetic moment. The larger the mass and the faster the velocity of the particle, the smaller the spin radius. The smaller the spin radius of the particle, the faster the spin velocity and the larger the equivalent annular current ***i*** (Zhang and Qi,1997).

4.12. A strong correlation exists between the magnetic interaction force of two protons within the effective range of a nuclear force and spin velocity.

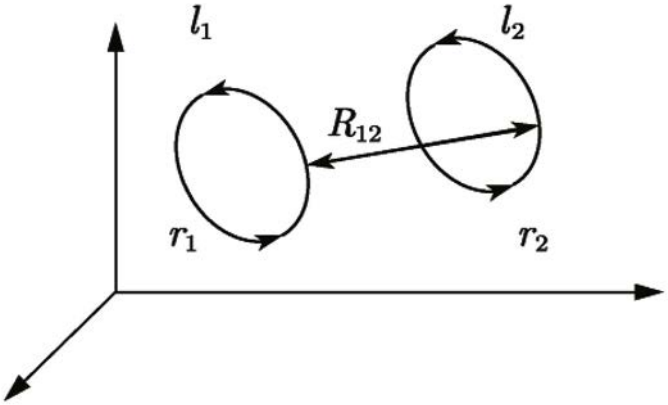

FIG. 4 A brief description of the magnetic interaction between two protons due to spin formation: proton 1 spins to form ring current element i_1dl_1; proton 2 spins to form ring current element i_2dl_2; to simplify the calculation, the ring current element planes formed by the spin of two protons are assumed to be parallel to each other and coaxial, and the distance between them is R_{12} (Zhang and Qi,1997).

A large initial velocity can overcome the electrostatic repulsion between protons. As the distance between the two proton bodies becomes closer, their respective spin radii decrease, and their respective spin speeds increase. The magnetic force caused by the spin gets stronger instead of changing with the inverse square of distance, as the electrostatic force is traditionally understood. The magnetic force between protons varies inversely with the fourth power of distance (Ding and Qiu,2019).

This study obtained new electron and proton body radii with calculations. It is concluded that the energy of the electron increases, the body radius decreases, and the particle mass is inversely proportional to the body radius. Simultaneously, a new model of a black hole is obtained that is highly consistent with the Kerer–Newman black hole's singular ring rotating at the speed of light. The radius of the black hole body, the electric field intensity at the black hole body radius, the magnetic induction intensity of the eddy current magnetic field at the black hole body radius, and the rotational angular frequency at the black hole body radius cannot be quantitatively calculated by previous

models. In particular, this paper concludes that as long as the mass of the black hole is not infinite, the electric field intensity at the radius or the singular ring of the black hole body, the magnetic induction intensity of the eddy current magnetic field at the radius of the black hole body, and the rotational angular frequency at the radius of the black hole body are max imum rather than infinite values. This result provides a way to solve the problem of infinite matter density and gravitational field strength inside the black hole of general relativity, combine general relativity with quantum theory, or combine the physical theory describing the macroscopic world and the microscopic world into a truly complete natural theory. Fifth, it provides a way to unify the gravitational and electromagnetic fields and establish a unified field theory.

The results of the above five aspects are worthy of further theoretical research and discussion by theoretical physicists. Similarly, the above series of calculated and predicted values are worthy of further consideration and verification by experimental scientists.

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