High Energy Radiation Mechanism of a Pulsar Accretion Disk and Black Hole Essence

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Abstract: The fundamental substances of a neutron star black hole are neutrons, and there are no charges in a neutron star black hole. The supermassive black hole of a quasar has much greater universal gravitation, and electrons and protons must not exist. Because there are no charges in the black hole, the black hole has only a gravitational field, and it cannot generate electric and magnetic fields, and it cannot emit photons. Hence, a black hole is essentially a dark star. This paper reveals that a pulsar black hole has an accretion disk that rotates at a super-high speed. The positive ions in the high-speed rotating accretion disk, generate a super strong pulsed magnetic field at the two poles of the pulsar black hole. The high-speed positive ions and free electrons in the accretion disk decelerate violently in the process of random collisions and generate high-energy photons of X-rays and γ-rays. Therefore, the super magnetic field and high-energy X-ray and γ-ray of a pulsar are generated not by the neutron star black hole itself, but rather by the high-speed positive ions and free electrons in its accretion disk. When the high-speed rotating pulsar absorbs the adjacent matter to form an accretion disk, its rotation speed slowly decreases. When the rotation speed of the pulsar decreases to a certain speed, even if the pulsar absorbs the matter nearby, it cannot form an accretion disk. Finally, the pulsar evolves into a silent neutron star black hole with only a gravitational field. As dark stars, black holes do not have the so-called determined event horizon, but the supergravity of black holes causes the gravitational redshifts of the magnetic fields and photons that are generated by the high-speed moving charges in the accretion disk. The magnetic field radiation mechanism of the accretion disk also provides a new theory for the study of the origin of the earth's magnetic field.

Keywords: black hole, neutron star, pulsar, accretion disk, positive ion, magnetic field radiation, X-ray and γ-ray, dark star, event horizon, gravitational redshift.

1. Introduction

In the late stage of the evolution of a star, the core collapses due to the cessation of thermonuclear reaction, and the material density increases dramatically. Assuming that the mass of the sun is M_S, if the mass of a star does not exceed 1.4 M_S [1], a white dwarf is formed. If the mass of the star is greater than 1.4 M_S, the gravitational collapse leads to higher material density, electrons are squeezed into the atomic nucleus to combine with protons to form neutrons, and a neutron star is formed. The upper limit of the mass of a neutron star cannot be determined as accurately as that of a white dwarf. According to modern observations, the mass of the black holes of neutron stars can reach tens of times the mass of the sun. This type of black hole, which evolves from stars and has a mass several to dozens of times that of the sun, is called a “stellar black hole.” In 1963, astronomical observations found another kind of supermassive special object, called a quasar, which could form a “supermassive black hole” with a mass that is billions of times that of the sun.

The fundamental substances of a stellar black hole are neutrons. A stellar black hole has extremely high mass density and extremely fast rotation, and most stellar black holes have diameters of about 10,000 meters. Due to the huge gravity of a black hole, it can attract nearby matter. The nearby matter forms an accretion disk on the central vertical section of the two poles of the black hole's rotation axis. The matter in the accretion disk is sucked into the black hole in a spiral path. The closer the matter is to the black hole in the accretion disk, the faster it rotates. The accretion disk causes the black hole to release X and γ high-energy rays and form a super-strong magnetic field in the two poles of the rotation axis. Modern astronomical observations can detect periodic high-energy pulse signals. These types of neutron star black holes are called pulsars. Pulsars are neutron star black holes with accretion disks.

Since the first discovery of pulsars in the 1960s, researchers have discovered thousands of pulsars. Pulsars are mainly divided into two categories. One category is binary pulsars, which are generally composed of a neutron star black hole and a companion star. The neutron star black hole can continuously absorb material from its companion star to form a stable accretion disk, which generates periodic high-energy pulse signals. The other category is single-star pulsars, which absorb nearby materials intermittently and generate intermittent high-energy pulse signals. Pulsars are the most widely studied type of neutron star black holes. However, there are still many doubts about the formation mechanism of a pulsar's super strong magnetic pulses and high-energy X-ray and γ-ray pulses, which require further study.

An electric field, a magnetic field, and a light field are the position characteristics, velocity characteristics, and acceleration characteristics of the charges. The only way to generate an electric field is with the existence of the charge, the only way to generate a magnetic field is with the movement of the charge, and the only way to generate photons is with the change of the charge energy level and the change of the charge velocity. This provides a theoretical basis for the study of black holes.

2. Accretion disk mechanism

The fundamental substances of a neutron star black hole are neutrons. A neutron star black hole has a very high mass density and spins very quickly. Without losing generality, letting the mass of the neutron star black hole be M_B, the radius be R_B, and the spin speed be ω_B, the center point of the neutron star black hole sphere is O, and the Z axis is the spin center axis, that is, the polar axis of the neutron star black hole. The X axis takes the spherical center O as the origin and is perpendicular to the polar axis Z, so the X axis is in the equatorial plane. The central section of the accretion disk is the equatorial plane, the thickness of the accretion disk is H, the outer edge radius is R_X, and the inner edge radius is the black hole radius R_B, as shown in Figure 2.1.

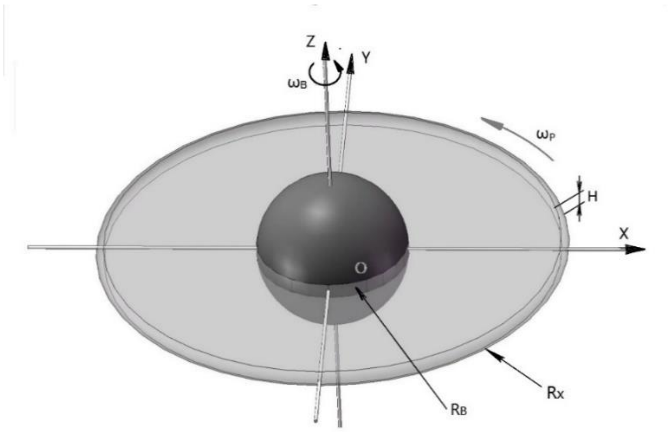

Figure 2.1 Structure of a neutron star black hole with an accretion disk

With the combined force of the universal gravitation and centripetal force of a black hole, the matter near the black hole dynamically accumulates near the equatorial plane of the black hole to form an accretion disk. The diameter of the accretion disk is much larger than that of the black hole. The atoms, protons, and electrons in the accretion disk can exist independently. With the combined force of gravity and the centripetal force, the matter in the accretion disk is sucked into the black hole in a spiral motion path, and the closer the matter is to the black hole, the faster its rotation speed is. In the accretion disk, the motion speed of the materials between layers is different, which generates a large amount of friction heat. At extremely high temperatures, the electrons escape from the atoms, forming negative electrons and nuclear positive ions. Because the positive ions are heavier, they move toward the black hole at a faster speed, while the electrons fall toward the black hole at a slower speed due to their lighter mass. Figure 2.2 shows the distribution diagram of the positive ions and electrons in the equatorial plane of the accretion disk.

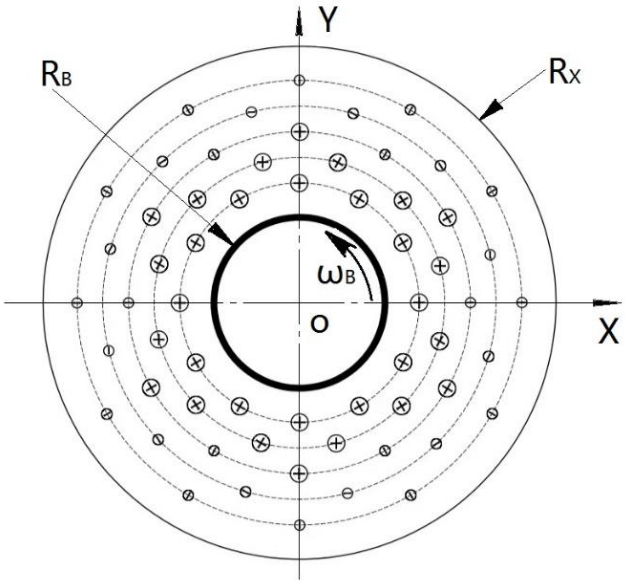

Figure 2.2 Distribution diagram of the positive ions and electrons in the equatorial plane of the accretion disk

Taking the average radius of gyration of nuclear positive ions in the accretion disk as R_P and the average velocity of gyration is ω_P, the average radius of gyration of the electron is R_e, and its average velocity of gyration is ω_e. Figure 2.2 above can be simplified as shown in Figure 2.3.

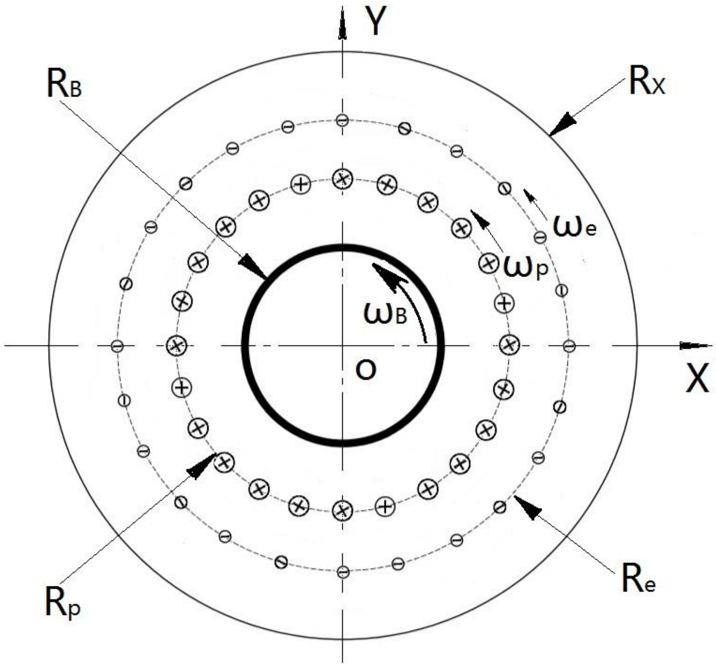

Figure 2.3 Simplified distribution diagram of positive ions and electrons in the equatorial plane of an accretion disk

3. Magnetic field radiation mechanism of the accretion disk

A moving charge generates a magnetic field, and the only way to generate a magnetic field is with the movement of a charge. The magnetic field intensity **B** at any point A in space is as follows.

$$\mathbf{B} = (\mu_0/4\pi)\, q\, \mathbf{v} \times \mathbf{r}/r^2 \qquad (3\text{-}1)$$

where μ_0 is the vacuum permeability, $\mu_0 = 4\pi \times 10^{-7}\ N{\bullet}A^{-2}$, **v** is the velocity of charge q, r is the distance from point A to charge q, and **r** is the unit vector of r.

As shown in Figure 2.3, the charge of a positive ion in the equatorial plane of the accretion disk is q_c=1.602x10^{-19}C, and its velocity is $v = R_p\omega_p$. According to Formula 3-1, the magnetic field intensity generated by a positive ion on the central axis of the black hole is as follows.

$$\triangle B_p = (\mu_0/4\pi)\, q_c\omega_p/R_p \qquad (3\text{-}2)$$

The charge of an electron in the accretion disk is q_c=1.602x10^{-19}C, and the magnetic field intensity generated by an electron on the central axis of the black hole is as follows.

$$\triangle B_e = -\, (\mu_0/4\pi)\, q_c\omega_e/R_e \qquad (3\text{-}3)$$

According to Equations (3-2) and (3-3), the magnetic field intensity generated by a pair of positive ions and an electron on the central axis of the black hole is as follows.

$$\triangle B = (\mu_0/4\pi) q_c (\omega_p/R_p - \omega_e/R_e) \qquad (3\text{-}4)$$

Because $\omega_p > \omega_e$, $R_p < R_e$, then $\omega_p/R_p >> \omega_e/R_e$, and Equation (3-4) can be approximately simplified as follows.

$$\triangle B = (\mu_0/4\pi) q_c \, \omega_p/R_p \qquad (3\text{-}5)$$

Because the magnetic field intensity generated by an electron on the central axis of the black hole is much smaller, it can be approximately omitted.

Without losing generality, taking the radius of the black hole as R_B = 5,000 meters, the velocity of gyration of the black hole is 20 revolutions per second, that is, ω_B = 125.6 radians/s. Taking the radius of gyration of the positive ion layer as $R_p = 2.0R_B$ and its velocity of gyration as $\omega_P = 0.8\omega_B$, then R_P = 10,000 meters and ω_P = 100.48 radians/s. According to Formula (3-5), the magnetic field intensity generated by a positive ion on the central axis of the black hole is:

$$\triangle B = (\mu_0/4\pi) q_c \, \omega_p/R_p$$

$$= (10^{-7}) \times 1.602 \times 10^{-19} \times 100.48/10{,}000$$

$$\triangle B = 1.61 \times 10^{-28} \text{ T}$$

Based on cosmic observation, letting the magnetic field intensity of a black hole pulsar be 10^9 Tesla, the number of positive ions required is as follows.

$$N_p = 10^9/\triangle B$$

$$N_p = 6.21 \times 10^{36}$$

Assuming that the number of positive ions in the dynamic accretion disk is one ten-thousandth of that of atoms, the number of atoms in the accretion disk is as follows.

$$N_n = 6.21 \times 10^{40}$$

For a binary pulsar, the matter of the accretion disk of a black hole pulsar is obtained from the companion star. Assuming that the mass of the companion star is equivalent to that of the sun and the number of atoms is about $N_S = 10^{56}$, the number of dynamic accretion disks that can be generated by the companion star is as follows.

$$N_{ns} = N_S / N_n$$

$$= 10^{56}/(6.21 \times 10^{40})$$

$$N_{ns} = 1.61 \times 10^{15}$$

Assuming the lifetime of the companion star is T_S=1 billion years, then the time for the matter in the dynamic accretion disk to move from the outer edge to the surface of the black hole pulsar is as follows.

$$T = T_S / N_{ns}$$

$= 10^9 /(1.61x10^{15})$

$= 6.21 \times 10^{-7}$ years

$= (6.21 \times 10^{-7})(3.076x10^7)$ seconds

T =19.1 seconds

The above-predicted calculation values are consistent with modern observation results.

4. X-ray and γ-ray radiation mechanism of the accretion disk

When an electron jumps from the high energy level of an atom to the low energy level, the electron releases photons. The generation mechanism of X-rays and γ-rays is also due to the charge transition and sharp deceleration, so X-rays and γ-rays are categorized as high-energy photons.

As shown in Figure 2.3, the accretion disk contains a nuclear positive ion layer and an electron layer that both rotate at a high speed. The average radius of gyration of the nuclear positive ion layer is R_P, and the average velocity of gyration is ω_P. The average radius of gyration of the electron layer is R_e, and the average velocity of gyration is ω_e

For the positive ion layer in the accretion disk, the black hole radius is taken as R_B = 5,000 meters, and the rotation speed of the black hole is taken as 20 turns per second, that is, ω_B = 125.6 radian/s. Letting the average radius of gyration of the positive ion layer be $R_P=2.0R_B$ and the average velocity of gyration be $\omega_p = 0.8\omega_B$, then R_p = 10,000 meters, and ω_p = 100.48 radian/s. The velocity of the positive ions is given below.

$V = R_p \omega_p$

$= 10000x100.48$

$V = 1.0048x10^6$ meter/s

The velocity V is about one three-hundredth of the speed of light. The high-speed positive ions in the accretion disk decelerate violently in the random collision process and generate X-rays and γ-rays, which are high-energy photons.

The free electrons in the accretion disk also decelerate violently in the random collision process and generate high-energy photons of X-rays and γ-rays.

6. Conclusion

The fundamental substances of a neutron star black hole are neutrons, and there are no electrons and protons in a neutron star black hole. A neutron star black hole has no charge and cannot generate electric fields, magnetic fields, and light fields, so a neutron star black hole is essentially a dark star. For the supermassive black hole of a quasar, the universal gravitation is much greater, and electrons and protons must not exist. Neutron star black holes and quasar black holes only have a gravitational field, do not have an electric field and a magnetic field, and do not emit photons. Therefore, black holes are essentially dark stars.

Astronomical observations can only rarely find a silent black hole with only gravitational fields. The thousands of black holes that are currently observable are almost all neutron star black holes, which are called pulsars. Pulsars have an accretion disk that rotates at a high speed. Positive ions in the accretion disk, which rotates at a high speed, generate a super magnetic field on the two poles of the neutron star black hole. The high-speed positive ions and free electrons in the accretion disk decelerate violently in the process of random collisions and generate high-energy photons for X-rays and γ-rays. Therefore, the super magnetic field and high-energy X-rays and γ-rays of pulsars are generated not by the neutron star black holes themselves, but rather by the high-speed positive ions and free electrons in the accretion disks.

When a high-speed rotating pulsar absorbs the adjacent matter to form an accretion disk, its rotation speed slowly decreases. Furthermore, when the pulsar's rotation speed decreases to a certain speed, even if the matter is absorbed from the vicinity, it cannot form an accretion disk. Finally, the pulsar evolves into a silent neutron star black hole with only a gravitational field.

As dark stars, black holes do not have the so-called determined event horizon; however, the supergravity of black holes causes the gravitational redshift of magnetic fields and photons, which are generated by the high-speed moving charges in the accretion disk.

The magnetic field radiation mechanism of the accretion disk also provides a new theory for the study of origin of the earth's magnetic field. The earth's atmosphere has a huge ionosphere, which stretches from 50km to 1000km above the ground. There are quite a lot of positive ions and free electrons in the ionosphere. The earth's rotation drives the positive ions and free electrons in the ionosphere to rotate, thus forming the earth's magnetic field.

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Availability of Data and Materials:

All data generated or analysed during this study are included in this published article and its supplementary information files.

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