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Formation Process and Essential Characteristics of Quasars

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Abstract: Since the discovery of quasars in the 1960s, people have been curious and confused about quasars' characteristics such as high brightness, long distance, large redshift, high energy and wide spectral lines. Until the mid-1990s, with the improvement of observational techniques, the mystery of quasars was gradually revealed, and one of the important achievements was the observation of the host galaxy of quasars, which is the active galactic nucleu. Although the discovery of active galactic nuclei has made a leap in the study of quasars, it also raises a series of questions for further study of quasars: First, the energy radiated by a quasar can reach more than a thousand times the total energy of the galaxy, is its energy source still nuclear fusion? Secondly, to maintain the continuous activity of active galactic nuclei requires a large amount of fuel, how is this fuel efficiently transported to the core region? Thirdly, observations show that the brightness of quasars can change dramatically in a few days or even less, what is the physical mechanism that causes this change? Fortunately, the author has recently studied and proposed a new theory of galaxy formation and evolution, which can be used to reveal the formation process and essential characteristics of quasars, solving easily the above problems.

Keywords: Black hole, quasar, active galactic nucleus, formation process, essential characteristics.

1. Introduction

The discovery of quasars was one of the four major astronomical discoveries of the 1960s [1]. Although the discovery of quasars has greatly promoted people's understanding of the evolution of the universe, people are puzzled by the features of quasars such as high luminosity, long distance, huge redshift, high energy, and wide spectral lines [2]. Until the mid-1990s, with the rapid development of astronomy and the significant improvement of observation technology, the mystery of quasars was gradually uncovered. Through the analysis of the quasar image, scientists confirmed that quasars are actually a class of active galactic nucleus (AGN), there is a supermassive black hole in the core of every galaxy, under the strong gravity of the black hole, nearby dust, gas and a part of the stellar material around the black hole, forming a giant accretion disk with high-speed rotation. In the inner part of the accretion disk, near the black hole's event horizon, matter falls into the black hole, creating a jet of matter along with a huge radiation of energy. Strong magnetic fields constrain these jets so that they can only be ejected at high speeds along the magnetic axis, usually perpendicular to the plane of the accretion disk. If these jets are right in front of the observer, the quasar can be observed, otherwise it is difficult to find the quasar. Although the discovery of AGNs brought a leap forward in the study of quasars, it was far from a through revelation of quasars [3]: (1) Some studies suggest that the enormous energy of an AGN may come from galactic collisions, but the exact details and physical mechanisms remain a mystery; (2) Large amounts of fuel are needed to sustain the nuclear activity of AGNs, but the source of this fuel and the mechanism of supply remain a mystery; (3) The brightness of quasars can vary dramatically over the course of a few days, and the physical mechanism that causes this change is still a mystery. Fortunately, the author has

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recently studied and proposed a new theory of galaxy formation and evolution, which can be used to reveal the formation process and essential characteristics of quasars, solving easily the above problems.

2. The Formation and Evolution of Galaxies

2.1 The Formation and Evolution of Planetary Systems

Just like the formation of the solar system [4], a star can produce several planets around it, and each planet can also produce zero or several satellites around it, therefore forming a planetary system, which is a hierarchical structure. But before the protostar derived its child planets, the surface temperature of the protostar was very low, especially the temperature at the poles was often lower than the melting point of ice, so a large number of water molecules were adsorbed at the poles of the protostar, forming a thick ice sheet. The surface of the poles of the protostar is fractured under the long-term erosion of ice meltwater, producing cracks or caverns connecting the mantle. When a large amount of ice water seeps into the mantle and meets the hot magma, a huge explosion pressure will be produced, causing a violent volcanic eruption. In the course of some violent volcanic eruptions, some debris such as ash, volcanic bombs and pumice stones can obtain the first cosmic velocity to enter the orbit around the protostar, and condense into the satellite orbiting the protostar and spanning the poles. These satellites become planets when the protostar become a star. Thus, a star generally has several planets that span its poles, such as the sun’s Jupiter, Saturn, Uranus, and Neptune.

Because a star is so massive, it has a thick atmosphere around them. With the rapid rotation of the star, strong cyclones will be generated at the two poles and many regions of the star. These atmospheric vortices can absorb a large number of clouds and condense and compress these clouds in the process of sinking, but the original angular momentum of the star remains unchanged, which will gradually accelerate the rotation of the star and drive the revolution of the child planets to accelerate, making the child planet gradually move away from the parent star along a spiral line.

As the planet gradually moves away from the parent star, the gravitational attraction of the parent star to the planet gradually decreases, so that the rotation speed of the planet gradually increases. If the planet has a large mass, it has a thick atmosphere, and during the rapid rotation of the planet, the poles of the atmosphere will produce vortices. When a satellite that crosses the poles rotates around the parent planet, it will pull the cloud through the top of the planet’s polar vortex, once this cloud is sucked into the planet’s polar vortex, it will be compressed, thus making the planet smaller, but keeping the planet’s angular momentum unchanged, which will make the planet spin faster, so that the satellite gradually away from the planet.

2.2 The Formation and Evolution of Stars

(1) The Beginning of a Star — A New Star

The formation of a star generally goes through the process from a satellite to a planet and then to a star. After the proto-star evolved from a satellite of small size and mass into an earth-sized planet, it generated some satellites, but it still revolved around its parent star, unceasingly accreted the nebula materials near the orbits to become larger and larger, and gradually moved away from its parent star with the frequent collisions of prograding planetesimals or the accelerating rotation of its parent star due to contraction [5]. Afterwards it met a series of impacts from some other planets running into it from behind, making it become a Jupiter-sized planet much farther away from its parent [6]. Since the Jupiter-sized planet’s mass is very huge, it can attract various gas molecules to form a dense atmosphere, and produce strong polar vortices during its rotation. Moreover, this kind of polar vortex can generate strong spiral currents, therefore form strong dipole magnetic fields, as is shown in Fig. 1, which is captured by NASA's Hubble Space Telescope.

Although Jupiter's mass is large enough to attract hydrogen in the atmosphere, making the mass ratio of hydrogen in Jupiter reach 75%, which is comparable to the mass ratio of hydrogen in the sun, yet Jupiter lacks oxidants, therefore cannot burn directly. According to scientists' estimate, only one giant has a mass 70 to 80 times that of Jupiter can it have enough gravity, pressure and temperature to cause fusion reaction between hydrogen elements. So the proto-star needs accreting enough interstellar material near its orbit to become a detonable star.

A series of strong polar vortices can be formed during the rapid rotation of the proto-star, as is shown in Fig. 2. This kind of vortex can continuously absorb hydrogen and other matter from the surrounding space to the proto-star, and they can also eject some material. Originally, the proto-star has at least two groups of vortices, located at the South pole and the North pole respectively, which can span troposphere and stratosphere. As plasma clouds swept in by a vortex of the proto-star sink faster and colder, after a long spiral path, at the bottom of the vortex, the velocity of the airflow is tens of times faster than that of scale 12 typhoon, so the cloud clusters have already condensed into ice, and the temperature in the vortex is much lower than that around it, hence from the distant place, the vortex looks like a small sunspot. But in fact, the central depth of the vortex can reach 200,000 kilometers, and its diameter can reach tens of thousands of kilometers.

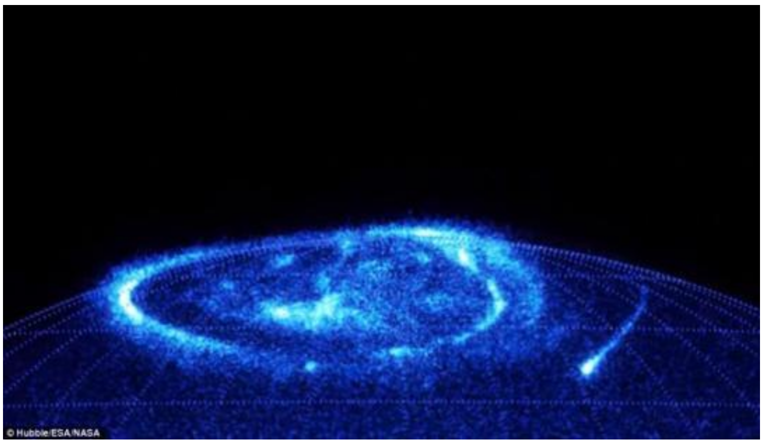

Fig. 1 The spiral current generated by Jupiter's arctic vortex.

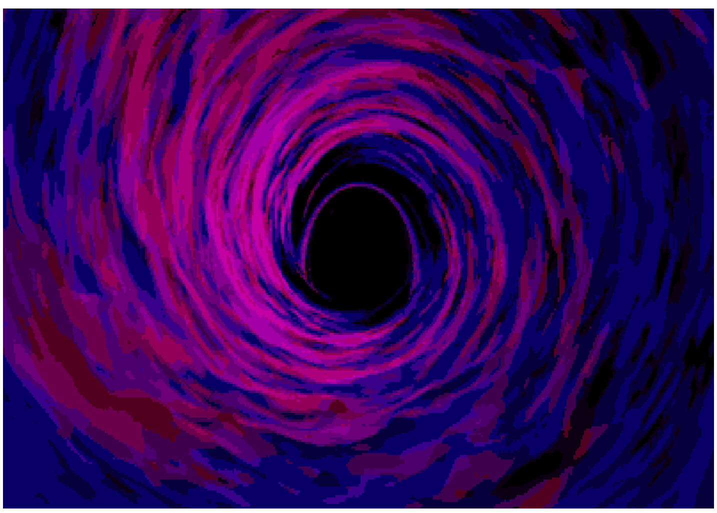

Fig. 2 Polar vortex on the proto-sar.

Since the clouds involved in a vortex are continuous and rotate downward rapidly in a spiral manner, a series of thick spiral cloud belts can be formed. In this kind of plasma cloud belts, the negative ions that get electrons are heavier than the positive ions that lose electrons, and then move down to the lower part of the cloud or even down to the bottom of the vortex along the spiral cloud belt. The lighter positive ions are gradually carried up to the upper part of the cloud or even up to the top of the vortex along the spiral cloud belt by the updraft, thus forming a current from the bottom of the vortex to the top of the vortex in the spiral cloud band. In addition, since the clouds along a spiral cloud belt are numerous and revolve rapidly, it is easy to have violent frictions and collisions among clouds, producing frequent electrical discharge or thunderstorms. Each electrical discharge or thunderstorm acts as an electrostatic motor, which can send currents to the upper portion or the lower portion of the vortex. Since a current from the bottom of the vortex to the top of the vortex has been formed in the spiral cloud belt, the dominant current in the spiral cloud belt is a current from the bottom of the vortex to the top of the vortex. Because this current flows continuously from the bottom of the vortex to the top of the vortex along the spiral cloud belt, thus forming a powerful dipole magnetic field with its magnetic north pole pointing towards the south pole of the proto-star and its magnetic south pole pointing towards the north pole of the proto-star, as is shown in Fig. 3.

In addition, since the coverage of a polar vortex on the proto-star is huge, the clouds involved in a polar vortex are numerous and revolve rapidly, when they get to the bottom of the vortex, it is easy to have violent frictions and collisions among clouds, and constantly generating violent lightning and releasing huge electric energy, making the temperature of the surrounding air rise rapidly to tens of thousands of degrees and the atmospheric pressure also rise to more than 1MPa, so the gaseous hydrogen in the vortex changes into liquid metal hydrogen. This kind of liquid metal hydrogen are gradually cooled as they sink rapidly along the spiral path. At the bottom of the vortex, the clouds condense into huge metallic hydrogen crystals, and some crystals are even larger than one Earth, for example, famous astronomer Nassim Halamin recently found from an image of SOHO that a white earth-sized object flew out of a sunspot region in the Sun's arctic area [9], as is shown in Fig. 4.

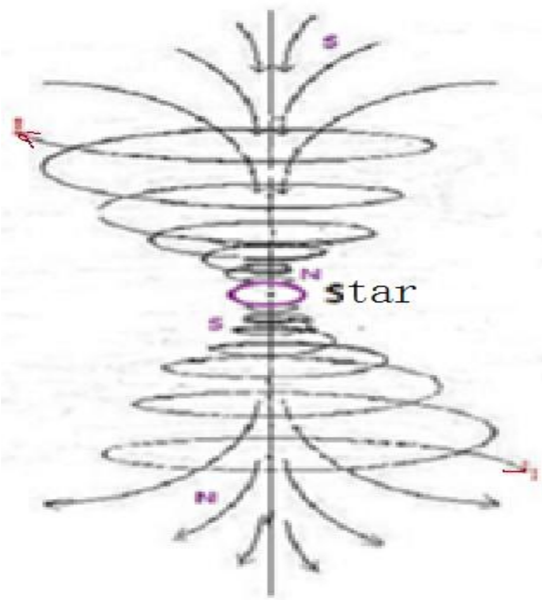

Fig. 3 Magnetic field of vortex.

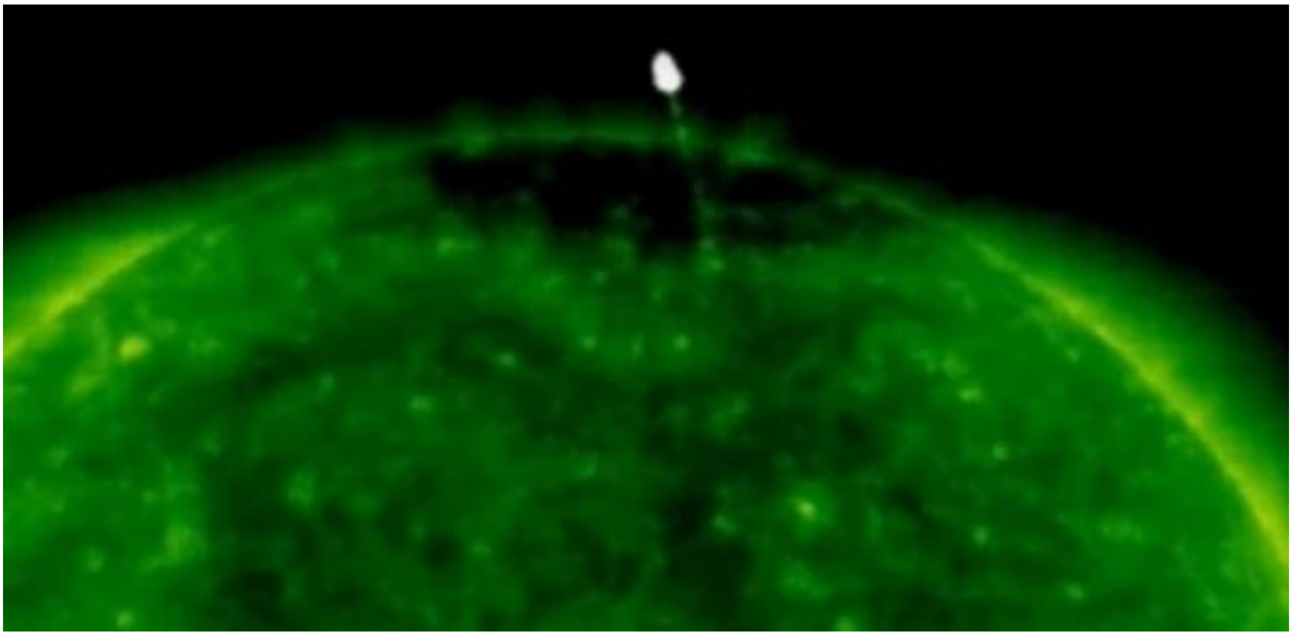

Fig. 4 An earth-sized object flew out of a sunspot region.

It is known that the internal temperature of Jupiter is about 280000 degrees and the internal pressure is about 40 million atmospheres. While the size and mass of the brown dwarf star that will become a star are almost equal to those of the sun, so its volume and mass are more than 1000 times those of Jupiter. Therefore, the internal temperature of this brown dwarf should be 280 million degrees, and the internal pressure should be more than 40 billion atmospheres. When the earth-sized metal hydrogen crystal hits the brown dwarf star, the explosion power of metal hydrogen is 50 times that of TNT explosive, which can increase the pressure nearby by dozens of times, exceeding 300 billion atmospheres. Hence, it can ignite the thermonuclear reaction of hydrogen to helium in the sunspot and cause a series of thermonuclear reactions beside the sunspot:

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n \ \mathbf{+17.6Mev}$$

Once a thermonuclear reaction is ignited, a large amount of energy is released in a short time, causing instantaneous heating in local area, generating all kinds of electromagnetic radiation, even many bright spots with rapid enhancement suddenly appearing next to the sunspot, which is the so-called solar flare. Because flares represent the eruption of solar thermonuclear reactions, there are violent explosions, which may change the structure of the sunspot or make it shrink or decay.

In general, the formation and disappearance of a sunspot can only take a few days to a few months, and it can attract a limited range of hydrogen gas, the hydrogen beyond this scope cannot be processed. So after the recession of a sunspot, without other sunspots to take over, the thermonuclear reactions ignited by this sunspot would cease. Fortunately, the star has multiple planets that can rotate rapidly around it, and when they get close to the sunspot cyclones at the Sun’s poles, they can tilt, stretch, shear, or break them through the action of gravity, and even drag out some sub cyclones, spreading them throughout the Sun. When a sub cyclone has absorbed enough air to become a long, large, heat-resistant cyclone, it falls from the upper layers to the lower layers, becoming a mature and strong sunspot. In this way, a series of sunspot cyclones can be generated throughout the star, continuing the thermonuclear reactions of the preceding sunspots.

Table 1 shows the ratio of the gravitation of the major planets of the solar system on the objects on the surface of the sun as well as the revolution periods of these planets. It can be seen that Jupiter has the strongest gravitation on objects on the surface of the sun, followed by the Earth and Mercury, but Mercury is the planet with the fastest revolution speed.

As can be seen from the above table, Jupiter has the greatest influence on the atmospheric vortices at the north and south poles of the Sun. With the rapid rotation of the sun and the rotation of the planets around the sun, the sun's sunspots can be spread by Jupiter, Earth, Venus, Mars and other from high latitudes to low latitudes. Then, some planets like Mercury ,which are close to the sun and move fast, will draw nebulae to sunspots near the orbits and add fuel to the thermonuclear reaction in the sunspot, allowing the thermonuclear reaction in the sunspot to continue, as shown in Fig. 5. This is the main sequence phase of a star, which lasts a long time.

Table 1 Ratio of the major planets' gravitation on the objects on the sun's surface as well as the revolution periods of these planets.

planet	mass	average distance from the sun	Ratio of planet's gravitation relative to Mercury's gravitation	revolution periods (Solar rotation period = 25.05 d)
Mercury	3.3022×10^{23} kg	57909050 km	1	87.9691 d
Venus	4.8690×10^{24} kg	108209184 km	0.42228	224.7 d
Earth	5.9650×10^{24} kg	149597888 km	2.70684	365.24 d
Mars	6.4219×10^{23} kg	227925000 km	0.12554	686.980 d
Jupiter	1.9000×10^{27} kg	778547050 km	31.8327	11.8618 yr

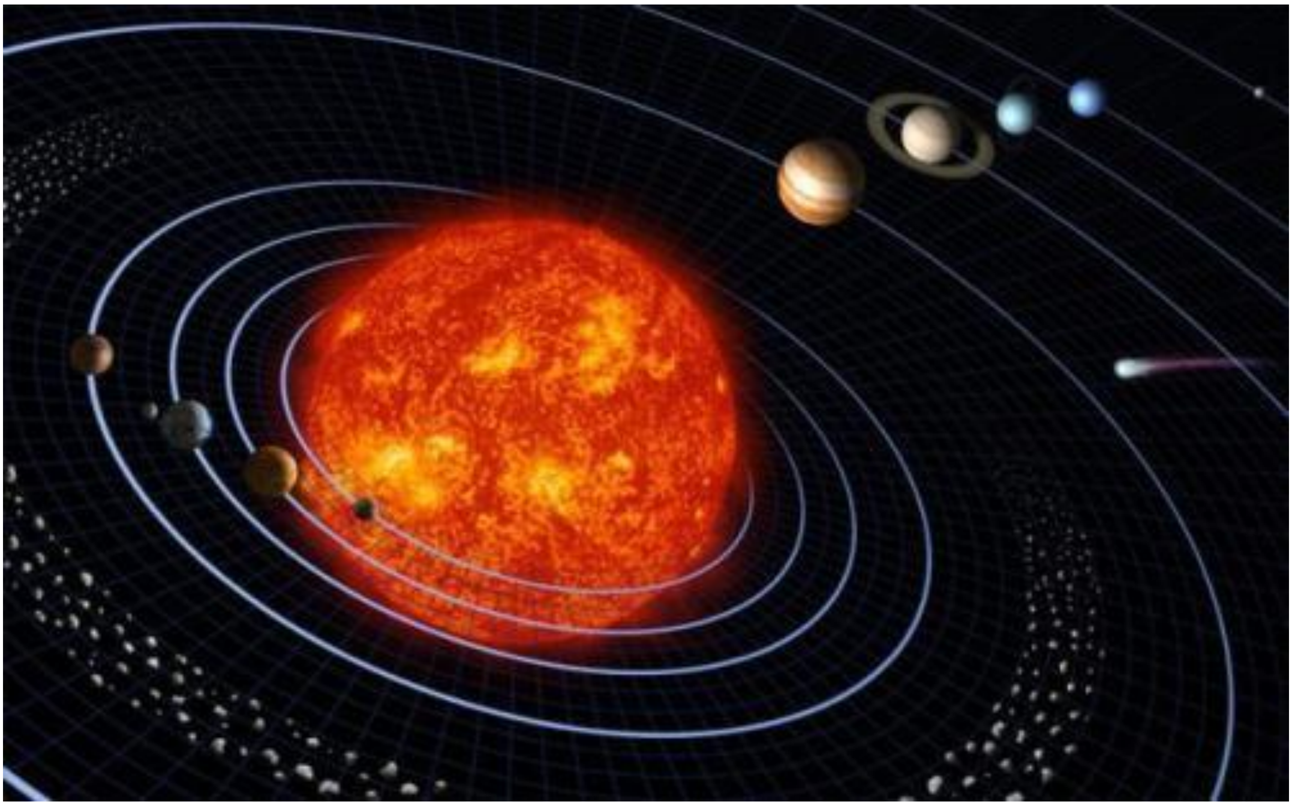

Fig. 5 Orbits of the eight planets in the Solar System.

(2) Middle Aged Star — Red Giant

In the process of a star rotating around the center of its galaxy, it continuously absorbs the gas, dust and other interstellar materials near its orbit by virtue of the cyclones on it. These trapped materials are difficult to escape from the dense atmosphere of the star. Therefore, after long-term evolution, the mass of stars increases greatly, even several times the mass of the sun.

Although the galactic structure is stable for a long time, collisions between galaxies occur from time to time on the astronomical time scale. For example, in the process of Jupiter rotating around the sun, it constantly absorbs the "nebula" material near its orbit and becomes larger and larger, but Mercury is in the hot environment strongly irradiated by the sun, and its mass will hardly increase. In addition, with the increase of Jupiter's rotation speed, Jupiter's satellites can move away from Jupiter at a certain speed and their mass increases gradually. When Jupiter becomes a star, the mass of some Jupiter moons can reach or even exceed that of mercury, and their diameter is larger than that of mercury. When such Jupiter satellites tend to the sun, they may collide with some inner planets in the solar system, as shown in Fig. 6, causing these inner planets to fall to the sun; especially, when the satellite reaches the orbit of Mercury, because the orbit of mercury around the sun is petal shaped, as shown in Fig. 7, the Jupiter satellite is likely to collide with Mercury, and the collision is enough to knock mercury down to the sun and finally be swallowed by the fierce fire of the sun. After the star engulfs some inner planets, the stellar mass increases significantly, the stellar atmosphere also thickens greatly, the internal temperature of the star rises greatly, and releases huge energy, which makes the star tend to expand. After the innermost planet of the star is swallowed, because there is no innermost planet close to the star to quickly spread new cyclones, the star cannot absorb enough hydrogen to maintain the hydrogen polymerization reaction inside the star, breaking the balance between the radiation pressure of nuclear fusion and its own shrinking gravity. Therefore, the internal helium nucleus shrinks and becomes hot, and the hydrogen shell expands and

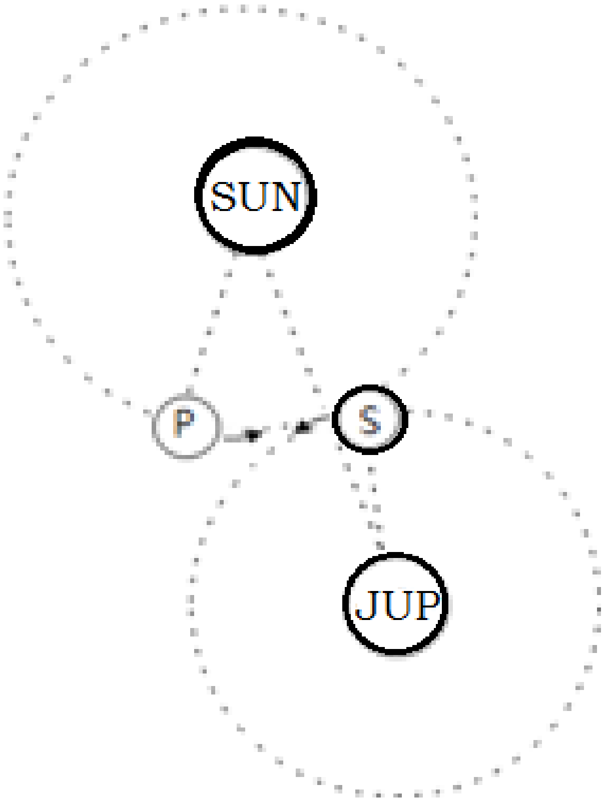

Fig. 6 Jupiter's satellite S collides with planet P in the solar system.

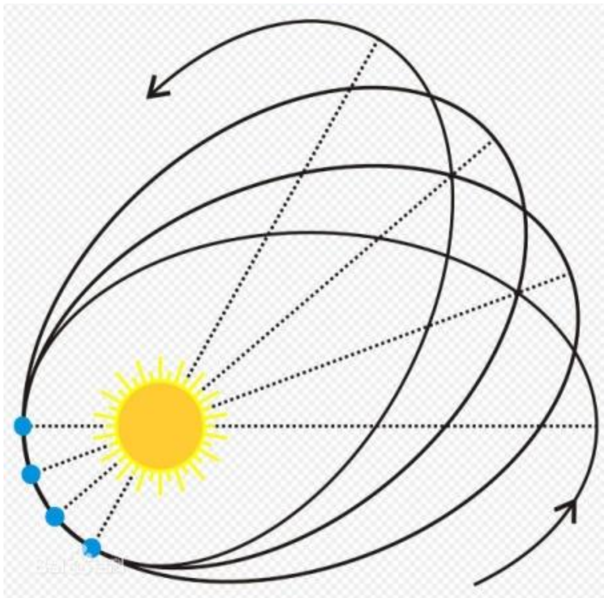

Fig. 7 Mercury's petal orbit around the sun.

cools outward. With the contraction of the internal helium nucleus, the rotation of the internal helium nucleus accelerates, and the hydrogen shell drifts outward under the action of centrifugal force, which makes the star expand rapidly into a red giant [7]. This process may last hundreds of thousands of years. The final result of helium fusion is the formation of a white dwarf in the center.

(3) Late Star —White Dwarf

After the red giant burns the innermost planet, because there is no innermost planet to quickly spread new cyclones that can absorb hydrogen and start thermonuclear reaction, the star cannot absorb enough hydrogen to maintain the hydrogen fusion reaction inside the star, and its internal temperature gradually decreases, which will break the balance between nuclear fusion radiation pressure and its own contraction gravity. As a result, the internal helium core shrinks and heats up, and the final core temperature will exceed 100 million degrees, so helium fusion begins again. However, when the helium core burns out, the central gravity of the star cannot be balanced by the radiation pressure generated by the hydrogen fusion or helium fusion, and the interior of the star shrinks. The contraction does not stop until the central gravity of the star is balanced by the electron degenerate pressure in the star center, forming a white dwarf, as shown in Fig. 8. Due to the small size of the white dwarf and the lack of inner planets that can quickly spread cyclones, there are far fewer cyclones that can produce thermonuclear reactions on the white dwarf than on main sequence stars. In addition, with the reduction of the star's volume, the density of its surrounding atmosphere increases greatly, so the brightness of white dwarfs decreases, darkens and turns white[8]. In particular, when the cyclones at both ends of the rotation axis of the white dwarf are not facing the earth, people can hardly see the light emitted by the white dwarf. At this time, people mistakenly think that it is a black dwarf without light. However, because the contracted star still rotates continuously, and the cyclones at both ends of the rotation axis will certainly emit light, there is no black dwarf that absolutely does not emit light.

Fig. 8 A white dwarf and its atmosphere.

(4) Rise From Dead — Supernova

Because a white dwarf or black dwarf is a star formed after the main sequence star engulfing the innermost planet, the mass of the white dwarf or black dwarf is significantly higher than that of the original main sequence star, and its atmosphere is also significantly thickened, but its volume is greatly reduced, even smaller than that of the moon, so its rotation speed is greatly accelerated and polar cyclones are greatly enhanced. If this kind of cyclone is not facing the Earth, people will not be able to detect its internal activities. However, if a planet around the star drags out a sub cyclone from the polar cyclone through gravity, and the sub cyclone just falls at a place (of the star) where Earth's people can see it, the people will be able to observe its activities. The sub cyclone can absorb a large number of clouds from such a thick atmosphere and quickly grow into a powerful cyclone, and then the large cyclone continuously sweeps a large number of heavy clouds from the deep and wide atmospheric space. These clouds go through a long spiral path to the bottom of the vortex and are compressed into huge metal hydrogen crystals. When this huge metal hydrogen crystal collides with the surface of the star violently, it will cause a violent explosion, generating a lot of heat and electric energy, reignite the thermonuclear reaction on the star, emitting a huge amount of energy and shine a very bright light, making the very dark or invisible star suddenly become an extremely bright supernova. The high brightness of supernovae can last for several weeks or even years, until it consumes a large part of the atmosphere accumulated by the star, it will gradually fade and become invisible. Supernova explosion is not the funeral of the star. When the atmosphere of the star becomes thick enough, supernova explosion may occur again, but it will take a long time. For example, iPTF14hls is an unusual supernova star that had erupted continuously for three years (as of 2017), as is shown in Fig. 9, and it had previously erupted in 1954 Therefore, there will be countless supernova explosions in the process of stellar evolution. In addition, giant objects falling from interstellar space to a white or black dwarf can also cause supernova explosions. A supernova explosion will make part of the falling object fly out at high speed, and then make the surface layer of the star melt and shrink into a thin onion layer [9].

(5) The Later Stage of Stellar Evolution — Neutron Star

After a main sequence star is transformed into a white dwarf, its mass is significantly increased compared with that of the main sequence star, and its atmosphere is also significantly thickened, but its volume is greatly reduced, even smaller than that of the moon, so its rotation speed is greatly accelerated, and its polar cyclones are greatly enhanced. In the process of the white dwarf rotating around the center of the galaxy, it constantly absorbs the gas, dust and other interstellar matter near the orbit by virtue of its strong polar cyclones, which makes its mass increase continuously, its gravitational force increases continuously, and the polar cyclones' involvement force and magnetic attraction increase continuously. Therefore, with the rotation of the white dwarf, a large number of clouds can be drawn into the polar cyclones and be compressed into huge metal hydrogen crystals at the bottom of the cyclones. When these huge metal hydrogen crystals collide with the stellar surface violently, they will not only directly produce huge pressure on the stellar surface, but also produce violent

Fig. 9 Supernova iPTF14hls.

explosion, producing greater pressure, and even cause thermonuclear reaction or supernova explosion, making the star collapse, which leads to great changes in the material structure of the star. In this case, not only the shell of an atom is crushed, but also the nucleus is crushed. The protons and neutrons in the nucleus are squeezed out, and the protons and electrons are squeezed together to form neutrons. Finally, all the neutrons are squeezed together to form a neutron star.

When a star shrinks to a neutron star, its volume will be greatly reduced and its rotation will be greatly accelerated, so that the dipole magnetic fields produced by the polar cyclones of the neutron star will be greatly enhanced, making people think that the neutron star is a very strong magnet. In addition, a neutron star emits electromagnetic waves through polar cyclones, but it generally has some planets around it, under the action of planetary gravity, the polar cyclones of the neutron star will deviate from the rotation axis of the star, so each polar cyclone of the neutron star moves along an elliptical trajectory during the rotation of the star. Hence, when a polar cyclone that emits the electromagnetic wave is facing the earth, the earth people can receive the electromagnetic wave; when the polar cyclone deviates from the earth, the earth people can not receive the electromagnetic wave. Therefore, the electromagnetic waves received by the earth people are intermittent, resulting in “lighthouse effect” [10], as is shown in Fig. 10.

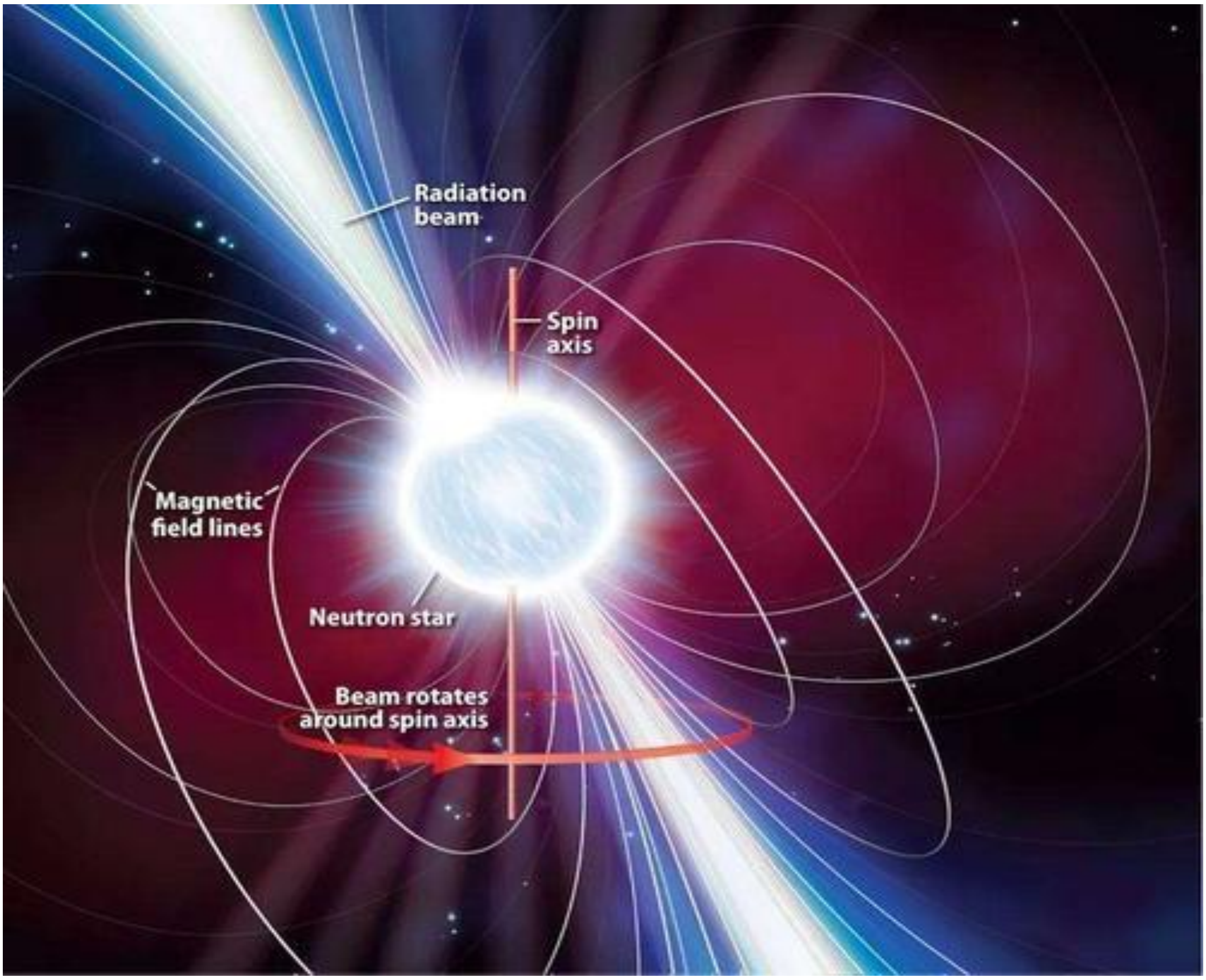

Fig. 10 A neutron star and its dipole magnetic fields.

(6) The End of Stellar Evolution— Black Hole

In the process of a neutron star evolution to a larger mass giant, its polar cyclones continuously accrete the gas, dust and other interstellar matter near the orbit, making its mass and surface continuously increase. With the rotation of the neutron star, a large number of clouds can be drawn into the polar cyclones and be compressed into huge metal hydrogen crystals at the bottom of the cyclones. When these huge metal hydrogen crystals collide with the stellar surface violently, they will not only directly produce huge pressure on the stellar surface, but also produce violent explosion, producing greater pressure, and even cause thermonuclear reaction or supernova explosion, making the star collapse further, which leads to the transformation of the atomic structure of the star surface into a neutron structure or a more dense structure.

In addition, during the expansion and movement of galaxies, collisions between galaxies occur from time to time. For example, a main sequence star (such as the sun) has multiple planets orbiting it (such as Jupiter and Saturn in the solar system). When the main sequence star evolves into a neutron star, one of its planets (such as Jupiter in the solar system) has also evolved into a main sequence star M, another planet P (such as Saturn in the solar system) and its satellite S (such as Titan) have also evolved into massive celestial bodies. With the increase of the rotation speed of the neutron star, its child star M moves away from the neutron star at a certain speed. With the increase of the rotation speed of giant planet P, P's satellite S also moves away from P at a certain speed, and the mass of S is getting larger and larger, making the shortest distance between S and M gradually decreases. Finally, there may be a collision between S and M, making M fall into the neutron star. Similarly, another planet of the neutron star may evolve into a main sequence star and later be knocked down on the neutron star. For example, on June 12, 2020, the American Astronomical Society reported that an international team of astronomers had observed the explosion process of a neutron star engulfing a star. The neutron star (No. “Sax j1808.4-3658”) continuously sucked away the material of a nearby star by virtue of its strong attraction. When the material plunder reached a certain degree, the star was drawn into the polar cyclones of the neutron star and eventually exploded. Naturally, neutron stars devour stars over and over again. When the mass of a neutron star exceeds three times the mass of the sun, a black hole is formed [11], as is shown in Fig. 11.

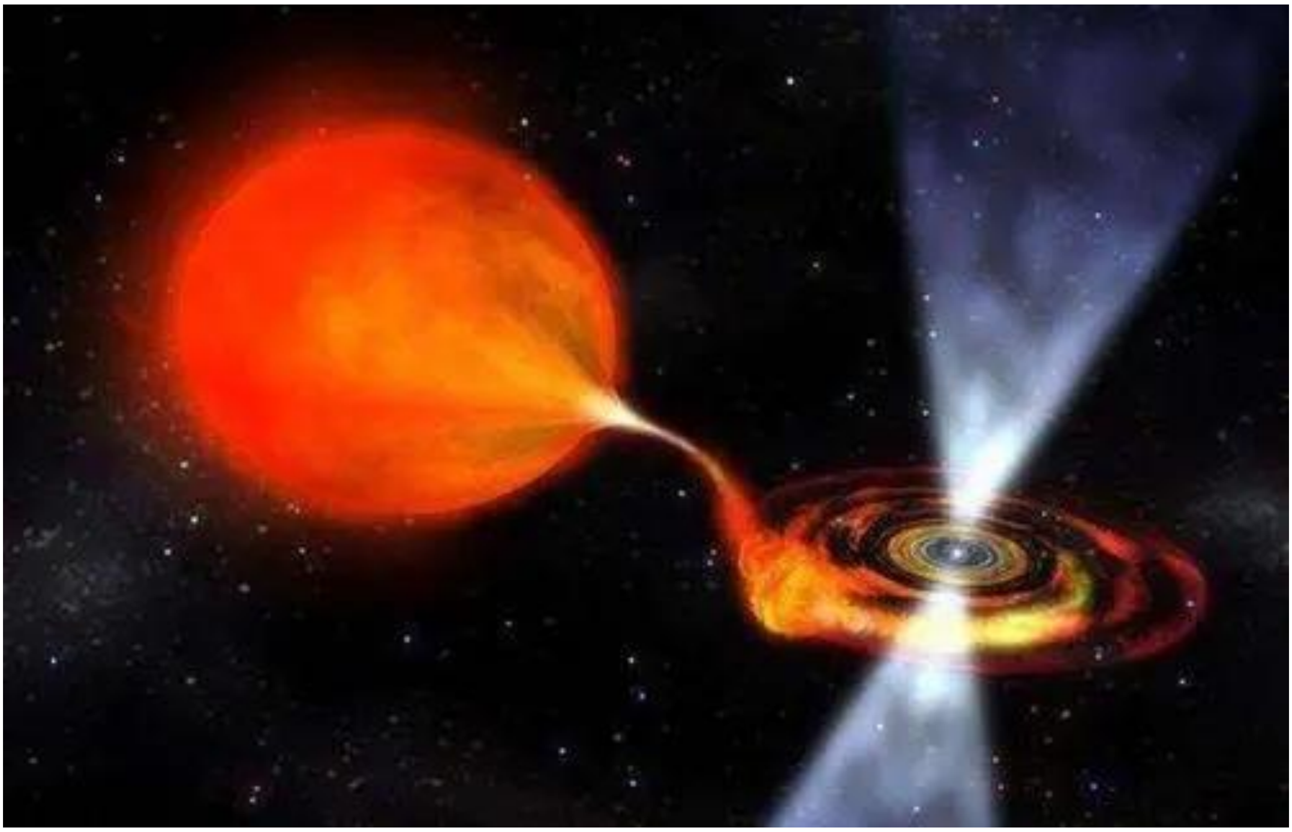

Fig. 11 A neutron star devours stars to become a black hole.

Due to the great mass and strong gravity of the black hole, when a luminous celestial body enters its gravitational horizon, many gaseous, liquid and solid substances of the celestial body will be immediately absorbed by the black hole, so that the resources of the celestial body are insufficient to maintain its luminous effect and extinguish the light, which is the reason why “light can not escape the black hole”.

2.3 Essential Characteristics of Quasars

Quasars are the result of the long-term evolution of galaxies in the universe, the process is very complex, and the results are also very strange [12].

(1) Quasars Are the Result of Stellar Evolution

Since quasars are supermassive black holes formed by stars in the galaxy through accretion of interstellar material near the orbit, and then formed after a long evolution process and swallowed many stars, it is the result of stellar evolution.

(2) Quasars Are Very Distant Stars

Quasars are highly distant and extremely bright objects in the universe, often located outside the Milky Way, millions of light-years or more from Earth. The latest study found that the most distant quasars are about 16 billion light years away, which is far beyond the tens of millions of light years in the vicinity of the Milky Way.

(3) Some Distant Quasars Are More Than a Thousand Times the Mass of the Milky Way

According to the formula calculating the distance between the central black hole of a galaxy and the central black hole of one of its sub-galaxy, and the ratio of the central black-hole mass to galaxy mass, we can easily calculate the ratio of the mass of a quasar billions of light years away from Earth to the total mass of the Milky way. Since a normal galaxy is a hierarchical structure and astronomers have discovered that our galaxy is a suburb of a supercluster of 100,000 large galaxies they have called Laniakea, we can assume that the Milky way's central black hole has multiple ancestral black holes. Assume there is n black holes from the Milky way's central black hole to a quasar billions of light years away from Earth, numbered respectively as BH_1, BH_2, … BH_n, and their correspondingly masses are M_1, M_2, … Mn. Let the total mass of the Milky way be m, then the mass of the Milky way's central black hole is $M_1 = 0.005m$. Just as the Milky way has two spiral arms, a large galaxy normally has two spiral arms, so the total mass of the galaxy centers on BH_2 should be $2m$, the mass of BH_2 should be $M_2 = 0.005 \times (2m) = 2M_1$. Similarly, we have

$$M_3 = 2M_2 = 2^2 M_1,\ \ M_4 = 2^3 M_1, \cdots,\ \ M_n = 2^{n-1} M_1$$

Because the diameter of the Milky Way is 10^5 light-years, its radius is 5×10^4 light-years. In order to make the Milky Way revolving around its central black-hole BH_1 not collide with BH_2, the distance between BH_1 and BH_2 must be greater than 5×10^4 light-years, and this distance does not change for a certain period of time. So the distance between BH_1 and BH_2 is about 5×10^4 light-years. Similarly, the distance between BH_2 and BH_3 is about $2\times5\times10^4$ light-years, the distance between BH_3 and BH_4 is about $2^2\times5\times10^4$ light-years, …, the distance between BH_{n-1} and BH_n is about $2^{n-2}\times5\times10^4$ light-years. Since the earth is at the outskirt of the Milky Way, and it is billions of light years away from the quasar, hence

$$5\times10^4 + 5\times10^4 + 2\times5\times10^4 + 2^2\times5\times10^4 + \cdots + 2^{n-2}\times5\times10^4 = 10^{10} \rightarrow 2^{n-1} = 2\times10^5$$

thus

$$M_n = 2^{n-1} M_1 = 2\times10^5 \times 0.005m = 1000m$$

i.e., the mass of the ancestral quasar billions of light years away from the earth is about 1000 times the total mass of the entire Milky Way galaxy, so it is massive enough to attract extreme thick and dense cloud, when it revolves around its progenitor and whirls on its axis fast, a wide range of continuous violent thunderstorms can be produced, the energy released by the quasar would be 1000 times more than the energy released by the entire Milky Way galaxy [15].

(4) The Redshift of Quasars Is the Hubble Redshift

Since a quasar is supermassive black hole formed by the stars in the galaxy through the long evolution process, it is always in the never-ending galaxy structure, rapidly rotating around its parent star, so the redshift of quasars is the Hubble redshift [13].

(5) Energy Sources and Fuel Supply Mechanisms of Quasars

Because quasars are the result of long-term evolution of galaxies in the universe, it is an active galactic nucleus evolved from stars through multiple stages such as red giant, white dwarf, neutron star, black hole, and supermassive black hole, so there is a rapidly rotating supermassive black hole in the active galactic nucleus. Under the strong gravitational pull of the supermassive black hole, as the black hole rapidly rotates, hydrogen gas, dust, and other interstellar material in the surrounding space form two powerful atmospheric vortices at the black hole's poles, which can reach a height of several light years, and when a polar cyclone faces the Earth observer, it presents a huge accretion disk. The accretion disk can become entangled in a large number of clouds, which are gradually compressed as they sink, becoming thicker and more massive,

After a long spiral path is prone to violent friction and collision, frequently produce strong lightning, so that the surrounding air temperature quickly rises to tens of thousands of degrees, the atmospheric pressure also rises to more than one million atmospheres, so many gaseous hydrogen in the vortex into liquid metal hydrogen. After a long spiral path, these clouds are prone to violent friction and collision, frequently producing strong lightning, the surrounding air temperature quickly rises to tens of thousands of degrees, and the atmospheric pressure also rises to more than one million atmospheres, so that much of the gaseous hydrogen in the vortex is transformed into liquid metallic hydrogen. This mixture of liquid metallic hydrogen and liquid hydrogen gradually cools as it descends rapidly down the spiral path and condenses into a series of huge crystals containing both solid metallic hydrogen and solid hydrogen at the bottom of the vortex. Since a quasar 10 billion light-years from Earth can have a mass of more than 1,000 times the total mass of the Milky Way, its central black hole can attract an extremely dense nebula, and its interior can reach the temperature and pressure of a star's thermonuclear reaction (15 million degrees and more than 300 billion atmospheres). When giant metallic hydrogen crystals collide in a black hole cyclone, they immediately ignite a thermonuclear reaction where hydrogen is fused into helium:

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n \ \mathbf{+17.6Mev}$$

When thermonuclear reaction occurs, a large amount of energy is released in a short period of time, causing a violent explosion of metallic hydrogen, producing strong electromagnetic radiation, and the emission energy of quasars can reach thousands of times more than that of ordinary galaxies.

Because there is a limit to how much hydrogen an active galactic nucleus can attract, hydrogen beyond its gravitational range cannot be sucked into the cyclone, and if the cyclone does not have enough fuel, its thermonuclear reaction will stop. Fortunately, the active galactic nucleus has rapidly rotating child galaxies, which are even larger than the Milky Way. They not only rotate rapidly around the active galactic nucleus, but also rotate rapidly around their own center, so the child galaxies can bring hydrogen and other nebulae from the vast universe to the gravitational range of the active galactic nucleus, providing a constant supply of fuel for the active galactic nucleus, as shown in Fig. 12, thus allowing the thermonuclear reaction of the galactic nucleus to continue. Thus, the thermonuclear reaction of the galactic nucleus continues. But when the central black hole of a child galaxy is close to its parent star, the active galactic nucleus' gravity can tilt, stretch, shear, or rupture the polar cyclone, causing the quasar's brightness to change dramatically in a few days or even less.

(6) Some Quasars Are Blue Stars

In 1965, Sandage discovered that the blue star body is essentially a quasar, but the luminous cyclone of the blue star body is not directly against the human eye, but away from the human line of sight or even behind the human eye, and the outside of this luminous cyclone is full of cosmic dust, so it is blue. In addition, because the cyclone of the blue star body is not facing the direction of the human eye, the radio waves it radiates are also away from the direction of the human eye, so people can not observe the radio waves emitted by this quasar [14].

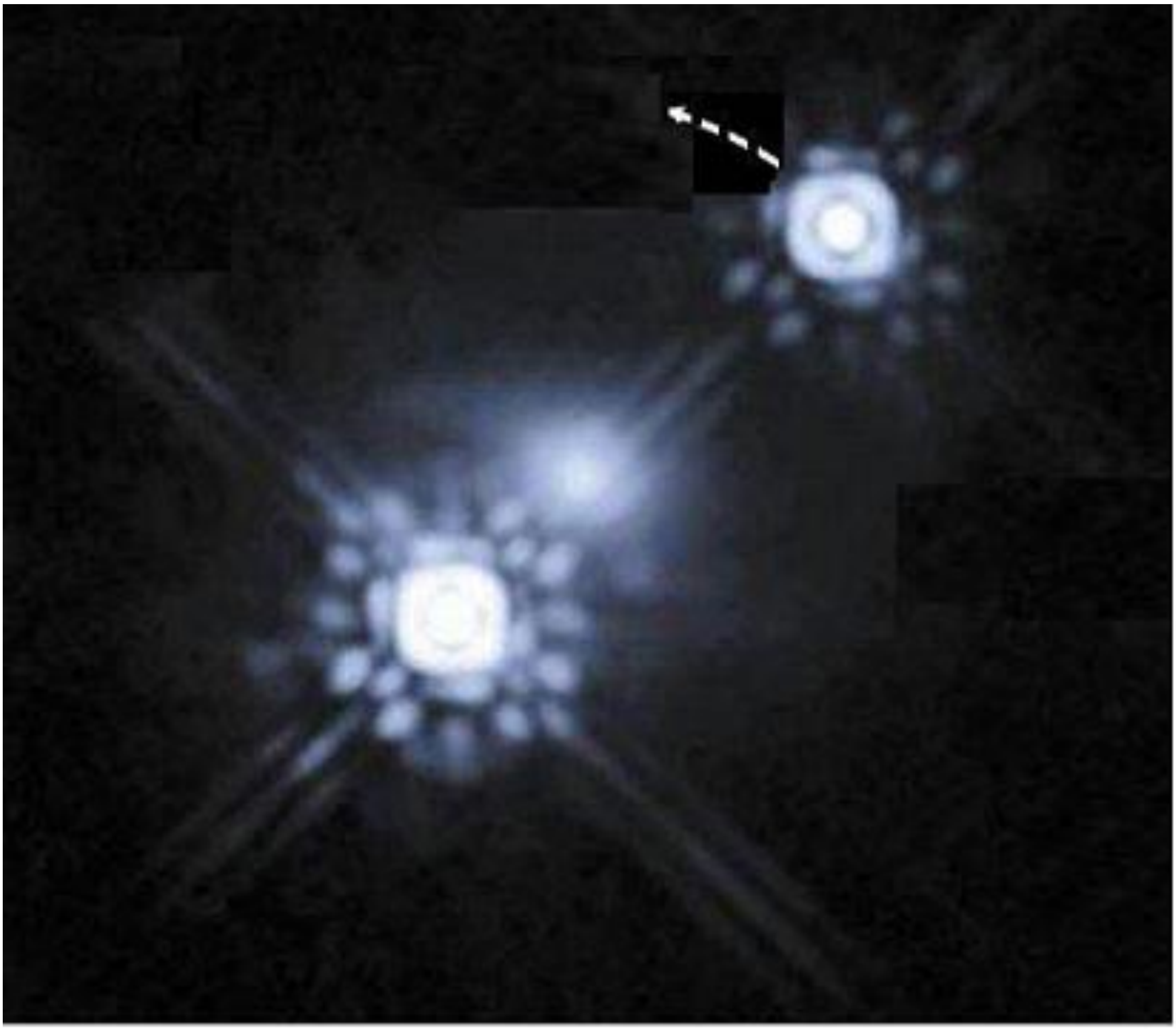

Fig. 12 The nucleus of the galaxy shines as it absorbs the fuel brought by its child galaxy.

3. Summary

The discovery of quasars, together with the cosmic microwave background radiation, pulsars and interstellar molecules, was listed as one of the four major astronomical discoveries in the 1960s, and has become a research hotspot in today's literature. Although the discovery of quasars is of great interest to astronomers, it also brings many problems that have long puzzled people. To this end, the author re-studies the formation and evolution law of satellites, planets and stars, and puts forward a new scientific theory of galaxy formation and evolution, thereby revealing the formation process and essential characteristics of quasars, especially pointing out the source of quasar energy and fuel supply mechanism and the reason why the brightness of quasars can change dramatically in a short time.

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