St.john Baptist De La Salle catholic school

Physics

Black Hole

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Introduction

Nobody normally witness light being affected by gravity because light moves so fast, but with careful observations it is quite measurable. Star light grazing the eclipsed sun, for example, is seen to bend inward as the light passes through the Sun's strong gravitational field. So light is pulled downward by gravity. Sunlight can leave our sun because the speed of light is much to collapse to radius of 3km, the escape velocity from its surface would exceed the speed of light, and nothing not even light could escape. The sun would be invisible. It would be a Black hole.

1 Origin of a black hole

If a star has mass smaller than 1.4M, its contraction is halted by the pressure of degenerate electrons. After these stars contract, they become white dwarfs. Somewhat more massive stars collapse until their neurons become degenerate and they become neutron stars. What halts the collapse of a star too massive to become a neutron star? The answer is that nothing stops the collapse. The star (or the core of a star) collapses until it forms a black hole and disappears.

The idea that stars could produce black holes was first proposed in the late 1700s by Pierre Simon Laplace. Laplace noted that an object can escape from the surface of a star only if the object has a speed greater than or equal to escape velocity. As the radius of the star decreases, its escape velocity increases. If the star gets small enough, the escape velocity at its surface becomes equal to the speed of light. Laplace reasoned that when this happened, not even light could escape from the star.

Figure 1: Pierre Simon Laplace who propose the idea that stars could produce black holes.

Laplace's thinking about black holes was based on Newtons' theory of gravity. In reality, however, black holes can be understood only through another theory of gravity- Einstein's general theory of relativity. Relativity explains gravity as a consequence of the curvature of spacetime.

In physics, spacetime is a mathematical model that combines the three dimensions of space and one dimension of time into a single four-dimensional manifold. Spacetime diagrams can be used to visualize relativistic effects, such as why different observers perceive differently where and when events occur.

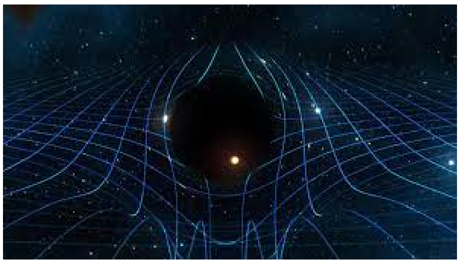

Figure 2: Figure of black hole and spacetime.

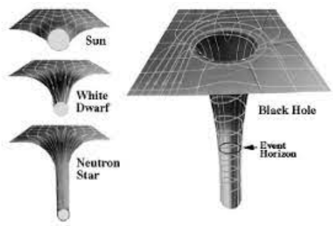

Figure 3: The relation of black hole in spacetime with other celestial objects in spacetime.

The sun, in fact, has too little mass to experience a collapse beyond a white dwarf. For ultra-supermassive stars, however, collapse beyond the neutron star is possible.The collapse of such a star continues until the star reaches infinite densities. Gravitation near the surface becomes so enormous that light cannot escape.

An ultra-supermassive star that collapse in to a black hole has the same mass before and after the collapse. So the gravitational field in regions at and beyond the star's original radius is no different in either case. An orbiting planet would keep on orbiting as though nothing happened. But beneath the star's original radius, the force of gravity increases exponentially.

Space itself becomes significantly wrapped. Anything that passes too close light, dust, or a spaceship- is inescapably pulled downward.

2 Black hole Geometry

If we shine a beam of light toward, but slightly away from, a black hole at precisely the right distance, we can direct the light into circular orbit the hole. This region above the black hole is called the photon sphere.

An indestructible astronaut with a powerful enough spaceship could venture into the photon sphere of a black hole. While within the photon sphere, she could still send beams of light back into the outside universe, if she directed her flashlight sideways and toward the black hole, the light would quickly spiral in to the black hole, but light directed vertically and at angles close to the vertical would still escape.As she drew closer and closer to the black hole, however, she would need to shine the light beams closer and closer to the vertical for escape. Moving closer still, our astronaut would find a particular distance where no light can escape. No matter in what direction the flashlight pointed, all the beams would be deflected into the black hole.

Our unfortunate astronaut would have passed through the event horizon, the mathematical boundary where no light within can escape. Once inside the event horizon, she could no longer communicate with the outside universe neither light waves, radio waves, nor any matter could escape from inside the event horizon. Our astronaut would have performed her last experiment in the universe as we know it.

The event horizon surrounding a black hole is often called the surface of a black hole, the diameter of which depends on the mass of the hole. For example: a black hole resulting from the collapse of a star 10 times as massive as the sun has an event horizon diameter of about 30km. Estimated redii of event horizons for black holes of various masses. The event horizon, however, is not a physical surface. Falling objects pass right through it. The event horizon is simply the boundary of no return.

Table 1: Amount of mass and radius of a black hole expressed in terms of celestial bodies

Black hole	
Mass of black holes	Radius of event horizon
1 Earth mass	o.8cm
1 Jupiter mass	2.8m
1 Solar mass	3km
2 Solar masses	6km
3 Solar masses	9km
5 Solar masses	15km
10 Solar masses	30km
50 Solar masses	148km
100 Solar masses	296km
1000 Solar masses	2961km

As space wraps around a black hole, so does time. Consider the following. If you could observe a clock falling in to black hole, you would see the clock ticking slower and slower as it fell towards the event horizon. Why? Because it takes longer and longer for the light from the clock to reach you. In fact, you would never see it fall through the event horizon because that would take an infinite amount of time.

The moment of collapsing supermassive star shrinks to the size of its own event horizon it is as long as its own event horizon. But gravity doesn't tun off and so contraction to smaller sizes continuous. The star the shrinks in size until finally it is crushed, presumably the side of a pinhead, then to the size of a microbe, and finally to a realm of size smaller than ever measured by humans. According to theory, what remains is a point of infinite density. This point is the black hole singularity. So a black hole has no physical surface. Instead, it is an infinitely small point.

Tidal forces would rip you apart before falling into a regular sized black hole. For a mega sized black hole, like the ome at the center of our galaxy, the tidal forces would be negligible-your spaceship would survive passage through the event horizon.

3 Scientific Significance of Black hole

Beside the fact that, black holes are massive and can pull anything to their inside because of their high amount of gravity, they have also some scientific significance, such as:

- Black holes are laboratories for testing basic theories that explain the beginning of the universe and how the universe works on the largest and the smallest scales, for example: Quantum physics and general relativity of theory.
- With learning about black holes, we can learn some sorts about the evolution of galaxies and especially about the evolution of dwarf galaxies.
- If anything we benefit from their existence. The stellar explosions that produce black holes also spew elements such as carbon, nitrogen and oxygen into space. The collisions of black holes and neutron stars help spread heavier elements, such as gold and platinum. This elements make up our Earth, and our own selves.

- As you might expect, the possibility of time travel involves those most extreme objects, black holes. And since Einstein's theory is a theory of space and time, it should be no surprise that black holes offer, in principle, a way to travel through space, as well as through time. A simple black hole won't do, though.

Conclusion

As we tried to explain black hole is a place in space with high amount of gravity that even light can't escape. It is created when a star collapse whether dying or in such a way. This place is invisible and not almost all stars change suddenly in to a black hole, that we tried to explain. For additional information the light that surround a black hole is called *accretion disk.*