What Is The Fate Of Matter That Falls Into A Black Hole And What Happens To The Matter In Their Vicinity?

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1 Background

What is it that captivates us about black holes? We as people are fascinated by that which we cannot understand. We watch unsolved crimes and read mystery stories where we are withheld from the truth. Human nature is innately curious about the mysteries and phenomena in the universe that we can't comprehend. Thus, our primal instincts and curiosities explain our captivation by objects such as black holes, which we are just beginning to understand. On top of that, black holes are incredibly interesting celestial objects that fascinate many people because of their ominous nature and sci-fi-like properties that don't seem possible to us.

2 What is a Black Hole?

A black hole is the remnant of a supergiant star that has died and collapsed onto itself to form a black hole, an entity, or a section of space where the gravity is so large that no matter, not even light, could escape from its gravitational pull. These form when supermassive stars, red giants, die and collapse onto themselves because they run out of hydrogen to fuse, therefore they do not produce enough energy to hold themselves up at the size that it is, so the outer shell of the star collapses onto the core. This collapse of the shell, if the star is over twenty solar masses, will compact the core of the star so much that it will form a singularity at the center and create an entity with a gravitational force powerful enough to not let photons escape its pull.

3 How do Black Holes Grow and Evolve?

Black hole growth will be a recurring topic and eventually tie back to the original focus question. Black holes grow by a process called accretion, which is where surrounding matter is pulled into the orbit of the black hole by its immense gravitational force, and then eventually pulled into the event horizon and the black hole. During this process, the gravity is so large that the matter is stripped apart until it is nothing but subatomic particles orbiting the black hole at incredible speeds. Because of these speeds, the particles emit a great number of X-Ray waves and light into the These subatomic particles then collect around the singularity in the center of the black hole, and when the matter around the singularity increases and collects, so too will the event horizon which will make the black hole grow. Another way that black holes grow in size is through merging. Black hole mergers are some of the highest energy-producing events in the universe and produce the largest and fastest growth in a black hole. This event occurs when two black holes come close enough to each other that they are affected by the other's gravitational pull. The two black holes start to orbit around each other in a circular motion, then, as they get closer and closer together, they speed up and finally collide to form a much larger black hole. This form of growth is much faster and will result in more substantial growth than the accretion of matter.

4 A Brief History of Black Hole Discovery

The idea of a black hole was first proposed in 1783 by John Michell, an English astronomer, and philosopher. He proposed the idea of a body of space where no light could escape. However, it wasn't until 1964 that astronomers found signs of evidence that contributed to the black hole theory. This was seen by astronomers noticing celestial objects, such as stars or planets, seemingly being affected gravitationally by an unseen force or object. These objects and stars

orbiting this dark mass were emitting X-Rays due to the black hole pulling on their matter and breaking apart the stars. The strange X-Ray emissions were noticed in 1964, but it wasn't until 1971 that the source of those X-rays was discovered to be the matter of a star orbiting the strange dark object. These were then classified as "black holes" for their ability to absorb and make matter seemingly disappear as if it fell into a deep, dark hole.

5 How are Black Holes Studied?

Because they do not emit light or any form of EMR, we cannot use telescopes to directly observe black holes, however, we can use telescopes to observe the matter surrounding the black hole and how their gravitational pull affects the matter around it. X-Ray telescopes such as the Chandra X-Ray telescope and the Event Horizon Telescope have been used to detect black-hole activity. When matter interacts with a black hole and the matter falls into its orbit and eventually is accreted into it, the matter expels amounts of energy and x-rays. Matter, such as stars or other cosmic dust/clouds, is torn apart and then sped up around the black hole due to its immense gravitational pull, which heats the matter and as it does this, the matter emits x-rays and other EMRs. These emissions are how we can study the activity and properties of specific black holes. Using this information, we can infer the diameter, mass, and motion/direction of a black hole. Black hole observations are mainly done using telescopes and mathematical equations to study their growth and evolution over time. Using these observations of EMR being emitted by the surrounding environment, we can create theoretical models of the black hole's accretion disks and the orbiting matter.

6 Physical Attributes of Black Holes

Black holes have many different physical features that distinguish them from other celestial objects in the universe. First and most obviously, their immense mass and density make it so that their gravitational pull can keep light particles from escaping their pull. This makes an area around the singularity completely devoid of light and is what we see and know as a black hole. The event horizon, which is the threshold or "surface" of the black hole, marks the boundary where in order to escape from its orbit and pull, you would need a velocity faster than the speed of light. The accretion disk is also very characteristic of black holes. Accretion disks are bright, glowing, flat disks surrounding each black hole that is made up of matter that the black hole is speeding up and will eventually accrete into its singularity. Accretion disks are quickly rotating and have very high temperatures because of this. They are made up of mainly subatomic particles which the gravitational pull of the black hole has stripped the matter down to. Another important physical feature of a black hole is that it rotates incredibly fast, and its accretion disk is built perpendicular to its axis of rotation. The singularity is the heart and center of the black hole and is the solid core of each one. The singularity lies in the direct center of the black hole and has a mass and density so great that it defies the laws of space and time. Any matter that is accreted into a black hole builds up around the singularity, which in turn makes the event horizon and diameter of the black hole much larger. The singularity is said to be an infinitely small point in space and the density and temperature of this point verges on infinity. There is much still to be learned about the singularity and it is a concept that we are still trying to figure out completely as it broke down our current understanding of space and time.

7 The Effects of Black Holes on Surrounding Matter

Black holes greatly affect the matter in their vicinity in many different ways. First and foremost is the process of accretion into a black hole. As I have mentioned before, any matter that comes within the strong gravitational pull of a black hole could eventually be accreted into the black hole. This is done by stripping the matter down to very small particles or even subatomic particles, and then the matter enters the accretion disk, where it speeds and heats up to incredible speeds and temperatures, and finally falls into the event horizon and ends up around the singularity. I will also mention the black hole's effect on time. As we know from Einstien's findings, time is relative, and that is shown in the case of black holes because time passes much slower for matter around a black hole. For example, one thousand days on Earth could equate to only one day around a black hole. The matter that falls into a black hole also goes through a process called "spaghettification", in which as it approaches the singularity, it is stretched vertically greatly and at the same time it is also compressed horizontally. This is due to the immense gravitational pull and the almost infinite density of the singularity. Black holes break down stars and devour all matter in their path through accretion.

8 Discussion

These findings are essential in understanding how black holes operate and what their true nature is. We learn about their growth, sizes, and structural properties from this information which puts us on the right track to fully understanding the mysteries presented to us by black holes. There are many obstacles that we need to overcome to fully understand black holes, and the main challenge presented to us is the distance between us and the black holes. We would need to get information from black holes only obtainable if we send a probe or other object into a black hole

and study its interactions and views with the black hole, however, there are many issues and challenges with this plan. The nearest black hole to Earth, Gaia BH1, is still 1,560 light years away from us, and we lack the means to travel that far or send a ship that great of a distance to study the black hole. Even if we sent a ship now that traveled near the speed of light, we still wouldn't be able to reach or observe it for another 1,560 years. Another challenge of studying black holes is the fact that they produce no light or EMR and cannot be studied directly through telescopes or any sort of instrument we have on Earth, which limits what we can study and what we can see of these black holes. We still have much to learn about black holes and we also lack the means as of now to thoroughly study them, which leaves future astronomers and astrophysicists with a great amount of work to do in order to comprehend the true nature of these objects, however, we have a great basis of information to build our research upon and begin our journey to uncover the mysteries of black holes.

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