BLACK HOLES: A MYSTERY OF THE UNIVERSE

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Black holes! The very name conjures up a mystery! What is at the bottom of the hole? What causes a black hole? What would happen if you fell into one? These questions and others provide one of the greatest mysteries of our Universe, one which has attracted much space in the newspapers, and one which has caused much discussion among astronomers.

A black hole, in simple terms, is an area in space, which gobbles up anything which happens to fall in, and never releases it. Once you get into a black hole, there is absolutely no way out!

A black hole is caused by the death of a very massive star, so in order to understand what causes black holes, we must first understand something about stars.

Stars are huge balls of hydrogen gas, with small amounts of other elements mixed in. In the centre of the star, the hydrogen is so compressed that the atoms of hydrogen begin to fuse with each other in a reaction known as the "proton-proton reaction". (Protons are simply the major parts of hydrogen atoms.) In this reaction, four hydrogen atoms fuse together to make one atom of helium, the next heaviest element. In doing so, the atoms release great amounts of heat, light, gamma rays and other atomic radiation. It is this reaction, for instance, that makes the Sun shine, and thus, is responsible for the fact that there is life on the Earth. Also, it is precisely this reaction which occurs when physicists or military men test a hydrogen bomb. There is a great deal of light, heat and other radiation released!

This radiation coming up from the centre of the star, pushes up against the upper layers of the star. The upper layers of the star, on the other hand are pulled down by the gravity of the star. In most stars, like the Sun, for example, the two forces are exactly equal and the star is well-behaved and shines out like a good star should do!

When a star gets old, however, it begins to do unusual things. In old age, all of the star's hydrogen is used up, so the upward pressure

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becomes less. The star begins to fuse the helium which was the result of the hydrogen reaction. This produces less energy and the radiation pressure upwards is lessened still more. The upper layers, however, weigh just as much as they did before, and are still being pulled down by gravity. Since the upward pressure no longer is equal to the downward pressure, the star begins to collapse inward. Many interesting things happen at this stage in a star's life, but they would take up too much space to describe here.

Briefly, the end result depends on the original mass, or size, of the star. Small stars collapse to become "white dwarfs"; medium-weight stars become "neutron stars"; and the largest, most massive stars become black holes. In order to become a black hole, a star must be about six times the mass of the Sun, so there is no danger of the Sun becoming a black hole. Besides, the Sun has enough hydrogen fuel to last several billions of years into the future.

At this point, we must consider the Law of Gravity which is causing the collapse of the star. In simplest terms, the Law of Gravity says two things: that the gravitational pull between two objects depends on the mass of the objects, and it also depends on the distance between the two objects. In other words, the more massive the two objects, the stronger the attractive force between them will be; and the closer they are together, the stronger the force will be. So, now, let's consider what happens when a star begins to collapse.

Of course, the mass of the centre of the star and the mass of the outer layers do not change, but what happens when the star begins to collapse and the distance between the inner and outer sections of the star begins to shrink? As we said earlier, as the distance grows less, the force of gravity increases. As the force of gravity increases, the surface layers of the star are pulled down even more, increasing the force of gravity still more. And, to repeat what we said earlier, in the most massive stars this process keeps on repeating until the distance between the core of the star and its outer layers is zero!

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At this point the star disappears from view. What happens to the force of gravity then? Since the distance between the centre of the star and its outside is zero, the force of gravity must be as strong as possible, or as scientists say,"infinite". So what do we have in space? We have only a field of gravity, which is as strong as is possible!

Now suppose the star, which has shrunk to zero, is still giving off light. The light starts upward from the star, but because of the immensely strong gravity it is pulled back down towards the star. It cannot escape. The same is true of anything else near the star. It cannot escape the infinitely strong pull of gravity.

Anything that gets into the gravity of the collapsed star cannot escape. Thus, we have a 'black hole', black because no light can escape from it.

Since black holes give off no light or other radiation, how do we detect them? Well, in truth, only one has been possibly detected, by Dr.Thomas Bolton, an astronomer at the University of Toronto. Dr.Bolton has found an object in the sky, known as Cygnus X-1. This means that it is a place in the sky, in the constellation of Cygnus, that is giving off X-rays, the same sort of rays that allow doctors to take pictures of our insides. Since it was the first x-ray source to be discovered in Cygnus, it is known as Cygnus X-1.

What is happening at Cygnus X-1 is as follows. There were two stars circling about each other. They formed a "double star", and this is quite common in space. However, one of the stars collapsed to form a black hole. With a very strong source of gravity near it, the surface material of the remaining star began to leave and flow down into the black hole! As the particles of the star came closer and closer to the hole, they began to go faster and faster. When material is accelerated to extremely high speeds it gives off X-rays. Of course, when it enters the black hole, the material vanishes from existance and is never seen again! However, the X-rays can be detected by special instruments, and this is how Dr.Bolton came to detect Cygnus X-1.

What would happen if a spaceship full of astronauts entered into a black hole? No one knows for certain, although several theories have been put forward. One thing for certain is that the astronauts would

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probably be killed. However, here we are leaving the realm of science and approaching the domain of science-fiction. We can certainly say, however, that the astronauts would never be heard from again!

Astronomers are continuing to work on the problems of black holes and in the near future more will be written about them. In the meantime, we have the privilege of knowing about, and thinking about one of the strangest objects in our Universe.....the black hole!

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