Nature of Black Holes and Space-Time around Them

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Abstract

Based on the Mach's principle, black holes warp the space time in a way that geodesic for every object which is moving toward black hole start to bend and object starts to rotate around the black hole. Even light cannot be able to escape from the strong gravitational field of black hole. Before arriving to the Schwarzschild's Sphere, object faces with length extension because of the difference between amount of tidal forces on the nearest and furthest points of object that take the object apart and after passing the Schwarzschild's sphere, based on the Special relativity of Einstein, the parts of object face with length contraction.

At the Ergo sphere Region of black hole, a particle that gets into it will divide into 2 pieces, one of them falls into the black hole and another gets out of the Schwarzschild sphere very fast and it's called the black hole radiation.

According to the Diagram drawn by R. Rafini and J. Weeler, an object gets out of white hole in past space-time, it can be able to send signals to us and we can receive it but black hole which is located in future space-time, after object enters to the Schwarzschild's Sphere, the signals it sends won't be received.

In order to reach the third space-time which is like a mirror to our universe, our speed needs to exceed the speed of light to pass the Einstein-Rosen Bridge.

Introduction

Have you ever noticed when water swirl around the drain?

In 1783, John Michell, rector and leading scientist in the village of Thornhill, suggested that surface of gravity of some stars could be so strong that even light cannot be able to escape from them.

In 1915, Albert Einstein pointed out that gravity is a warp in space time caused by matter on general relativity.

The more massive an object, the greater it warps the space around it.

In 1916, German astronomer, Karl Schwarzschild found that enough matter packed into small enough space, would have such a powerful gravitational field that nothing can escape from it.

In 1963, Roy Kerr showed that massive stars will drag the space time around them like the water swirling around the drain.

His equations were just specified for black holes.

In 1963, Maurten Schmidt discovers an odd star-like point of light which right now we call them “Quasar”. This discovery was leaded to the realization that all the quasars are powered by super massive black holes.

In 1967, John A. Weeler, officially named “black hole” for these collapsed stars.

In 1974, Steven Hawking found that black holes are not black and they emit radiation that we will explain it on this paper [1].

Based on General relativity of Albert Einstein, there’s no “gravitational force” and the term “gravitational field” is used instead.

Also based on Mach’s principle, matter tells geometry how to curve and geometry tells matter how to move [2].

Black holes are the remains from super massive stars after supernova. Please notice that singularity is another word for Black Holes.

When the star collapses, the density goes to infinity. The more massive a star, the more it warps the space time and curves geodesic of an object falling into it if and only if the mass of the object coming toward it is less than the star’s mass. (Geodesic is the shortest distance between two points in space which is not always a straight line and if the two points are located in gravitational fields it will be a curve rather than a straight line)[3].

The gravitational field of black holes are so strong that even light cannot be able to escape from them.

Black holes are made up of 2 parts:

1-event horizon: a well-defined surface that nothing can be seen and escape, because the required escape velocity exceeds velocity of light [4]. It’s known as point of no return [5]. Based on Doppler Effect, objects while approaching to the event horizon have red shift in their spectrum because they’re getting further from us and closer to the black hole so fast [6], also because they come from the upper gravitational potential (far from the black hole) to the lower gravitational potential (event horizon), they emit X-rays before arriving to the event horizon. Black holes are categorized in group of X-ray binaries as the same as pulsars [7].

2- Black hole's cone: knowledge we have about this part of black hole is based on mathematical equations. Please note that the term "cone" is just the geodesic of matter going through black hole or in another word, it's the hypothetical shape of space-time near the black hole in 3 dimensions rather than 4 dimensions(3 dimensions of space and 1 dimension of time) because we are unable to imagine 4 dimensions.

Karl Schwarzschild, German Astronomer in 1916, found a formula for obtaining the radius of sphere around black hole that if any object enters into this sphere, it cannot be able to escape anymore and also if the object emits signal toward us, signal cannot be able to escape from strong gravitational field either.

Event Horizon is Schwarzschild's radius.

Schwarzschild's radius can be obtained by the following formula:

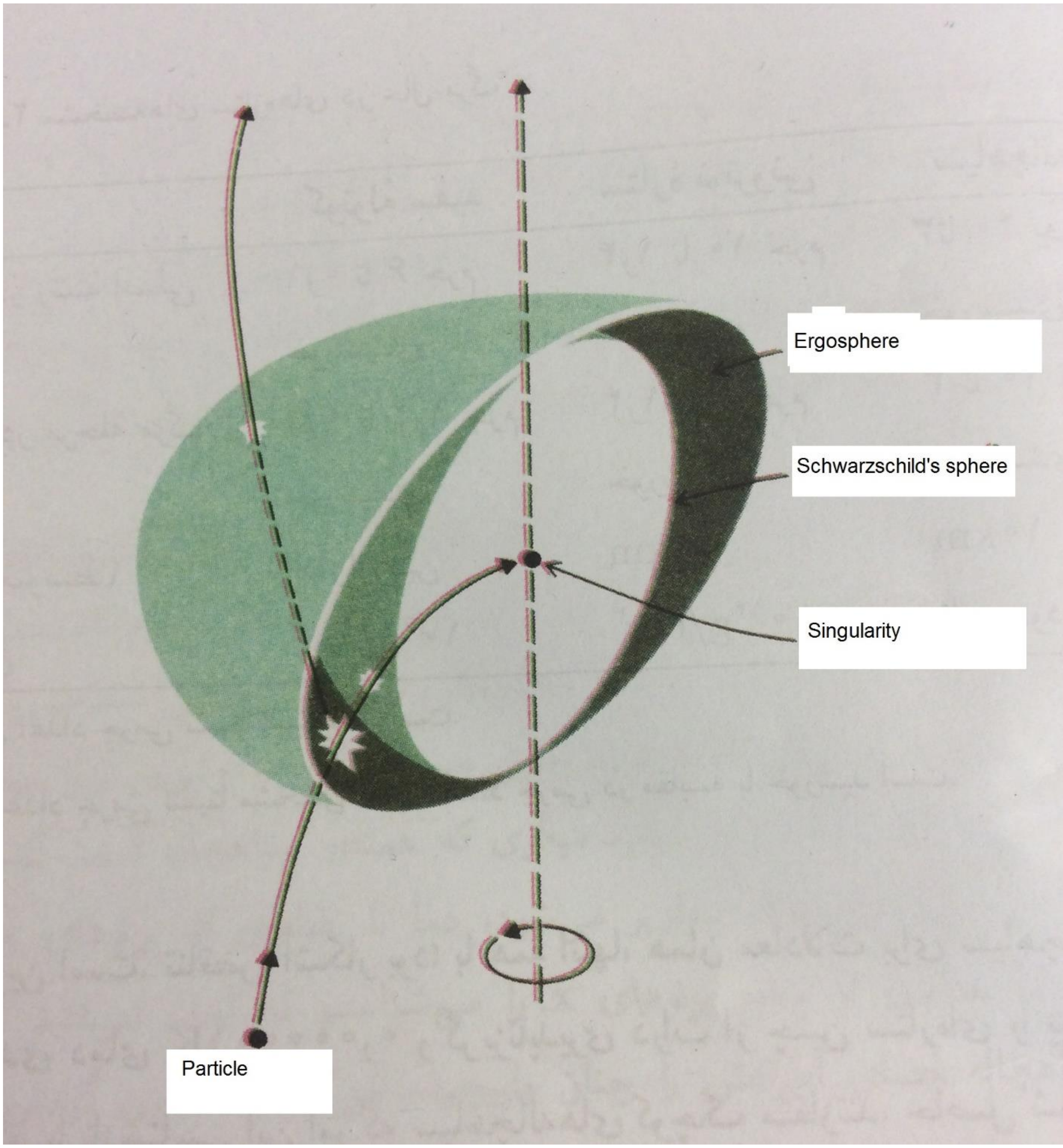
$$R_s = \frac{2Gm}{C^2} \tag{1}$$

There are 3 types of black holes:

1- Black holes located at the center of galaxies; this type of black holes are extremely massive and they can be able to hold the stars and interstellar gases around themselves.
2- Normal Black holes; this type of black holes is approximately impossible to find because they are like a

trap for beams of light, except some rare situations such as Cygnus X-1. Cygnus X-1 was the first time astronomers could find a black hole which is beside a red giant star. This is a source of X-ray because gases move from upper to lower gravitational potential and produce X-ray.[8]

3- Rotational black holes; In contrast to what we believe, black holes emit particles. When supernova takes place, star starts to collapse and based on angular momentum conservation, the rotation of star needs to increase until it turns to black hole and the poles of star get closer to each other, equator gets bigger and black hole’s shape is shown in picture 1. When a particle comes into the Ergo sphere, it turns into 2 pieces; one of them falls into the black hole and another, gets out of black hole very fast and it can be detected. Energy of the second particle, comes from the energy transferred from rotational black hole to the particle. [9]



Picture 1: when a particle comes into the black hole, in Ergo sphere, it turns into 2 pieces and one of them goes through Schwarzschild's sphere and another gets out of black hole very faster than the first particle

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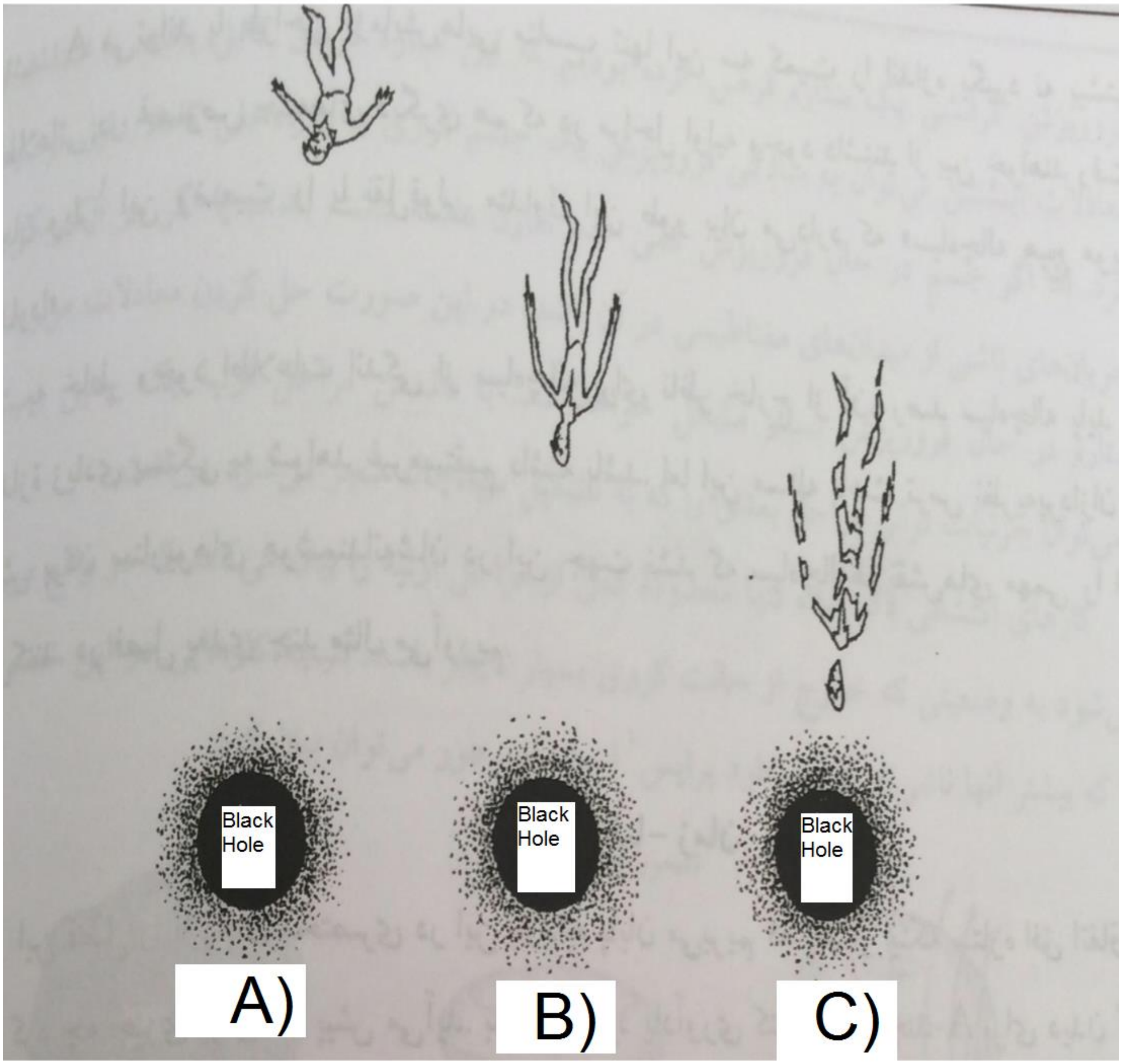
When an object approaches the Schwarzschild's sphere, because of the difference between amount of gravitational field on nearest and furthest points of object and also tidal forces acting on it, cause length extension and the object turns apart into pieces(picture 2) [10].



Picture 2: A) the object or human far from black hole. B) When it approaches to the black hole. C) When its position is so close to the Schwarzschild’s sphere.

After the pieces of object goes through Schwarzschild’s sphere, every piece of it faces with relativistic length contraction because based on angular momentum conservation, as the distance between pieces of an object and the center of black hole diminishes, the velocity of pieces of object gets higher and higher until it approaches to the speed of light [11].

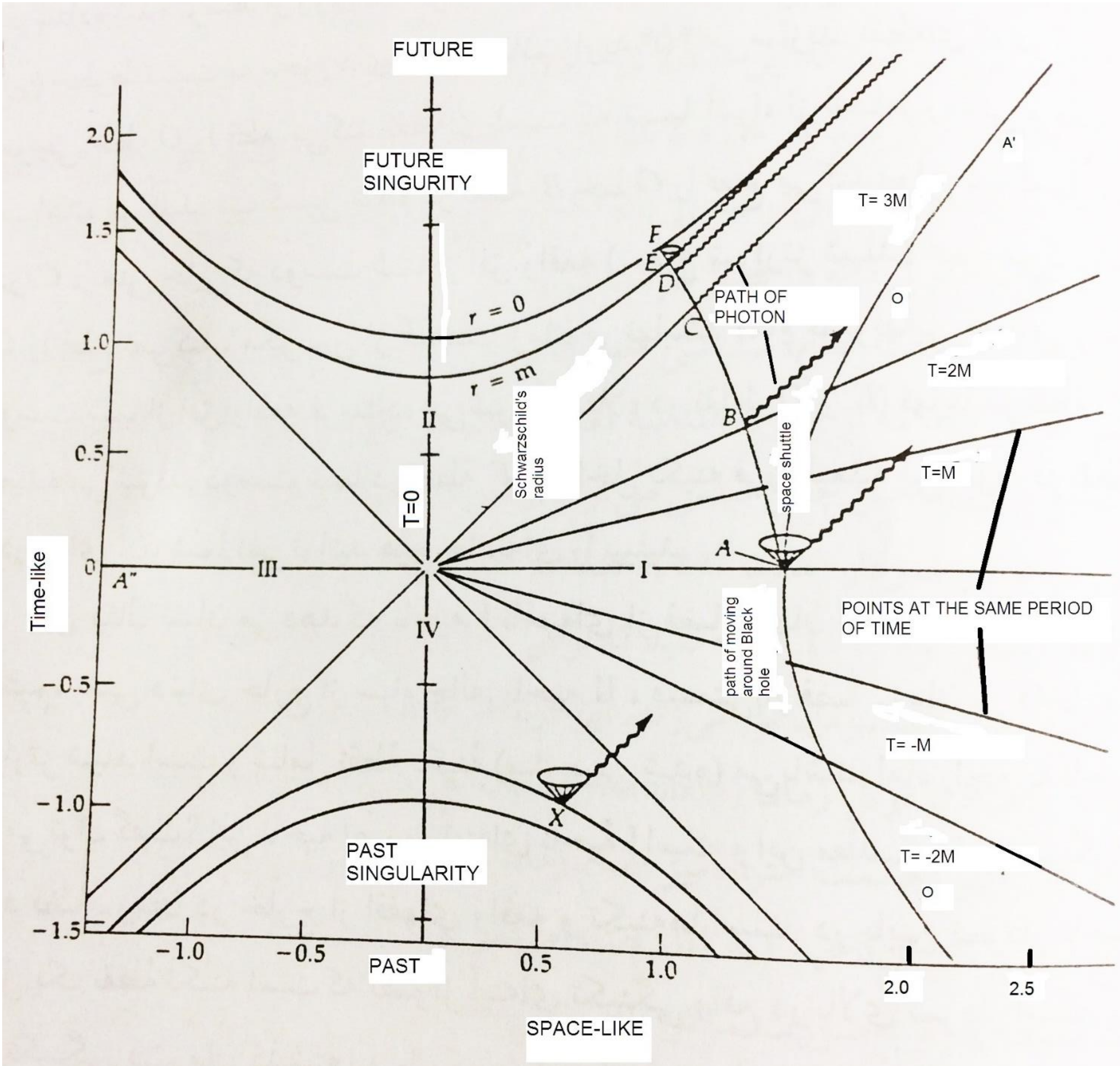
$$L = m(R \times v) \qquad (2)$$

So the based on relativistic length contraction we have:

$$L' = L(1 - \frac{v^2}{c^2})^{-\frac{1}{2}} \qquad (3)$$

So it can be possible that the pieces of object have some changes in their structure, such as neutron stars that when gases in star will be under strong pressure the electrons fall into the core of atom and interact with protons and make neutrons. But unfortunately there’s no evidence for that.

R. Rafini and J. Weeler, 2 scientists on 1967, represented the space-time near black hole in a diagram. (Picture 3)

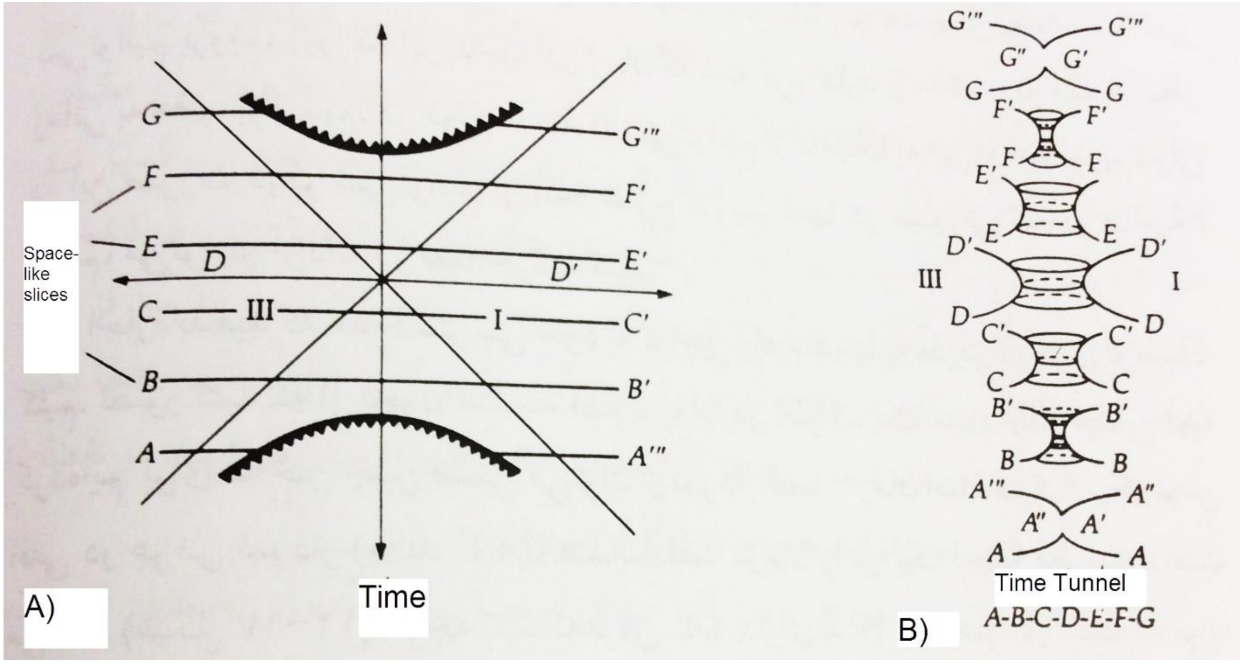


Picture 3: the space time near black hole. Astronomer approaches to the black hole (point A to F) and sends signals to his friend who’s moving on line O in the Space Shuttle and receives astronomer’s signals. Also when astronomer gets out of the white hole in past space-time on point X, he can be able to send signals to his friend and his friend can deliver them without any problem.

Imagine an Astronomer and his friend are going to have an experiment, astronomer wants to go through black hole and his friend stay away from black hole and take signals astronomer sends. Before astronomer arrives to the Schwarzschild's radius, he sends signals to his friend and his friend receive them without any problem (points A and B in picture 3) and his friend is traveling from past to the future in the space shuttle (line O in picture 3) But when astronomer enters to the Schwarzschild's sphere, no signal will be delivered by his friend (points C, D, E and F in picture 3).

In picture 3, there are 4 space-times; first one is our universe's space-time. The second one is the future space-time. Third one is like a mirror of our universe; we have no idea about this universe because it's unreachable except one condition.

We can be able to reach that universe through Einstein-Rosen Bridge or in other word, time tunnel. Although, time tunnel just opens in a short period of time. During this period, we need to go through it with a velocity more than the velocity of light. (Picture 4)



Picture 4: space-time evolutions near black hole. A) Space-time hypothetical slices from various periods of time. B) Geometry specified for each space-time slice. We can see the time tunnel which opens and closes very quickly. (From A to G)

Fourth one is the past space-time. Black holes have convergence and everything around them will fall into them by their strong gravitational field. But in this space-time, in contrast to black holes, we have divergence for objects which have already been fallen into black hole and they are called “White Hole”. As you see in picture 3, the astronomer that gets out of white hole, can send signals from point X to his friend without any problem and he will deliver it [12].

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