

BLACK HOLES AND THINGS AROUND IT

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INTRODUCTION

Do you believe in GOD? Do you know what will be the result on division with zero? For sure both things are hard to answer and there can be millions of explanations for these two questions. And if you think that these two things are impassable then what you will say about BLACK HOLES.

Because for Albert Einstein Black Holes are places where god is divided by zero. Hard to believe but true, Black Holes are one of the most bewildering things of the space even after the years of researches Black Holes has many unanswered questions and secrets.

For those who think Black Holes as a red herring Michio Kaku once said, "If you want to see a black hole tonight, 'tonight just look in the direction of Sagittarius, the constellation. That's the centre of the Milky Way Galaxy and there's a ragging black hole at the very centre of that constellation that holds the galaxy together."

Black Hole studies are super important because black holes have the power to create, sustain and destroy anything in the universe. Create and destroy here only means the transformation. But the studies of Black Holes are not that much easy because we really don't have any real black hole with us, if we do, right now Sir Stephen Hawking will be the Noble Prize winner.

This particular research paper will help you to know what really a Black Hole is, how these Black holes spend their massive life and why they are so much mysterious. We will also discuss over the things which surrounds the Black Holes or are present near the Black Holes because if you really want to understand any particular thing you should first understand its surrounding. We will learn about the formation of Black Holes, their stability. We will also discuss about its properties, both the lost ones as well as the new gained ones. The main focus in this paper is laid over the neighbours of Black Holes such as Event horizon, Quasars and Ergo sphere.

Birth of Black Holes

In very simple way, an ordinary black hole is thought to the end state of a really massive star's life. The hero of black holes stories, American scientist John Wheeler, in his work of 1950s and 1960s he emphasized that many stars would collapse and eventually will give birth to Black Hole.

Normal life span of an ordinary star is over many billions of years, and throughout this span it supports itself against its own gravity by thermal pressure, caused by nuclear processes which convert hydrogen into helium. The explosive forces of nuclear fusion inside the stars creates outward pressure named as thermal pressure which is constrained by gravity pulling everything inwards. A finally the doomed day comes when star get exhaust its nuclear fuel, eventually all the nuclear processes get stopped leading to the end of all thermal pressure and star starts contracting, and in some cases, it may be able to support itself as 'White Dwarf' star, they are the some of the densest objects of the universe. And in other cases, a uniform spherically systematic symmetric star would contract to a single point of infinite density and interminable gravity. Such point is called known as singularity.

A singularity is what you end up with when a giant star is compressed to an unimaginably small point so you can take singularity as an end point of the huge star but more fundamentally it is the starting point for the birth of black holes and formation of entire universe.

Black Holes' Behaviour

As I told you in introduction section that to understand something specially something like black hole it is really necessary to first understand the things present in it's surrounding. In this section I will try to show these neighbouring things controls and help us to know the behaviour of black holes.

Event horizon, Quasars and Ergo sphere will the centre of foci of our discussion. I will try to put all my research I have done about these three in most possible simple form.

Event Horizon

Event Horizon can be mark as the point of no return, at event horizon space and time get fundamentally changed, time get freeze at the horizon. Anything that happens below the event horizon stays below the event horizon. Nothing below the event horizon can escape not even the light.

There are few questions which can be answered by understanding the nature and properties of event horizon such as-

Are objects falling through the event horizon really, physically frozen there from the point of view of the outside universe?

Would we see the entire future history of universe play in fast forward at the instant we crossed the event horizon?

Do we see anything at all once we are inside the black hole?

And the best and possible way physicist use to understand the event horizon is THE PENROSE DIAGRAM.

Because the basic space time fails to do so, as any object crosses the event horizon, it's time cone get depend which make it impossible for us to understand it's nature below the event horizon then, and solution for this is PENROSE DIAGRAM.

The Penrose Diagram

It is a two-dimensional diagram capturing the causal relation between different point in space. It is an extension of a Minkowski diagram where the vertical dimension represent time, and the horizontal dimension represent space and slanted line at an angle 45 degree correspond to light rays.

The biggest difference is that locally, the metric on a Penrose diagram is conformally equivalent to the actual metric in spacetime. It is chosen in such a way that entire infinite space time is get transformed into a Penrose diagram of finite size.

In simple words Penrose diagram fits the infinite space time on just one graph.

Penrose diagram consist of distant future as well as time as infinity as shown in the fig.01, therefore under this diagram light cones have always same orientation.

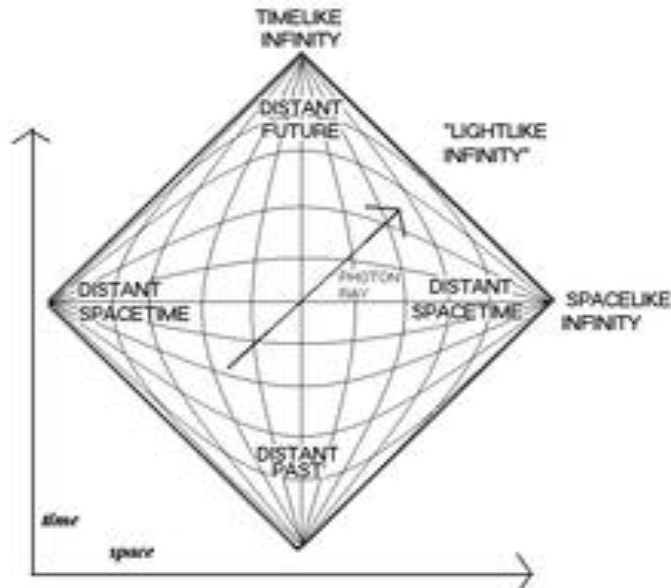


Fig.01

Light Cones

Space time surface is represented as a three-dimensional cone, comprising all the points from which a light signal would reach a given point simultaneously, and which therefore appear simultaneous to an observer at the apex.

A well labelled diagram of a light cone is given below-

Minkowski visualised space and time as a light cone defining a boundary between past and future accessible locations

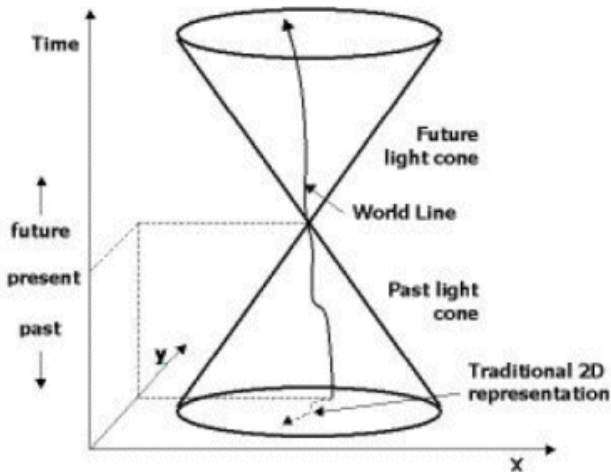


Fig.02

Yes, these are the light cones which decide what we will see-future, past or just a normal present.

Remember those three questions, given in the starting of this section, now we will try to get the answer of those by sending our pet monkey whose name is Hugsy into black hole.

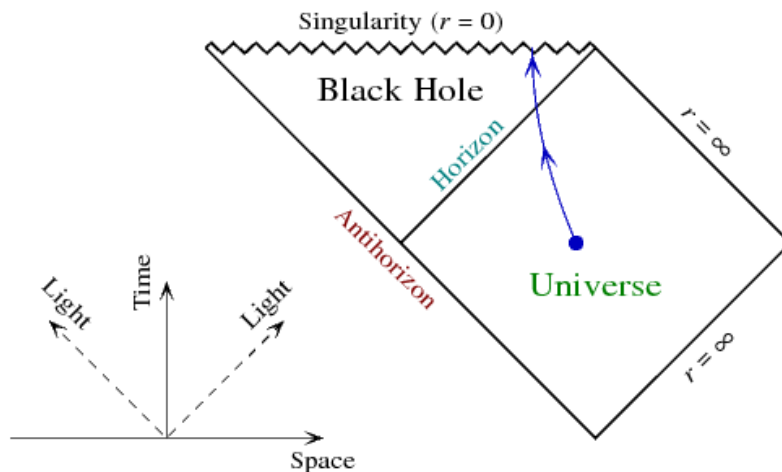


Fig.03

Let suppose that our pet Hugsy started its journey from the blue point as shown in fig.03 present somewhere in the universe, with its light cone in vertical direction such as forward light cone facing towards the event horizon.

As our pet reaches to the horizon, time will freeze out so the final signals of crossing the event horizon will never reach to us, for us, watching from outside we will be only able to see our pet Hugsy resting at one position until its image get vanished but will never be able to know when it entered the horizon.

Once our pet Hugsy crossed the horizon, its future cone will be towards the singularity, leading to its end so at that time Hugsy might be able to see complete past of the universe in fast forward.

As for us our pet is still outside resting near the horizon, so we launch a rescue mission. Which is just a waste because Hugsy has already crossed the event horizon and if our rescue aircraft also entered the event horizon, it will find Hugsy just below itself but never get it, until both met the singularity.

Ergo Sphere

In 1971 Remo Ruffin and John Archibald coined a new term ergo sphere, derived from a Greek word eigor means "work".

Ergo sphere is a region outside the event horizon, where gravitational force start influencing the movement of objects. The strength of influence depends on the distance between the object and event horizon.

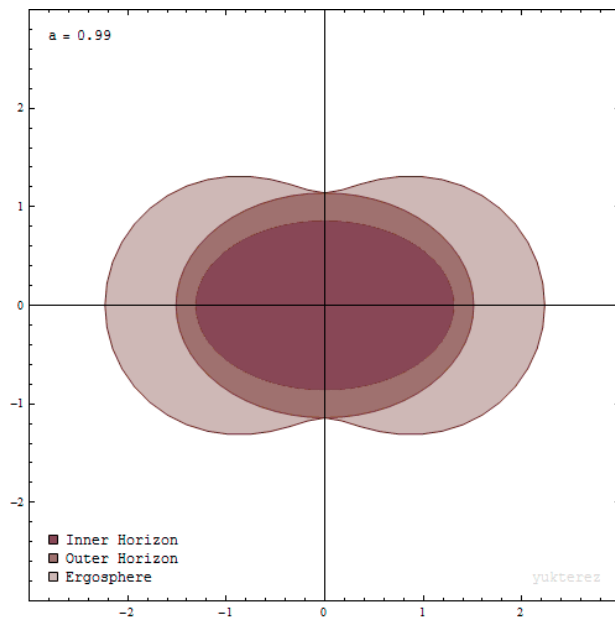


Fig.04

Fig.04 show how ergo sphere changes its radius around a rotating black hole. Maximum at the equator and touches the event horizon at the poles of the rotating black hole. So, when any object falls in the ergo sphere, what happen next with it? General Relativity theory predicts that any rotating mass drags surrounding space-time with it. This makes the ergo sphere not just a characteristic of black holes, but it is present with all regular cosmic objects of mass.

So, if any object is in ergo sphere it can easily come out of it ones it achieves the escape velocity, and when any object enters in the ergo sphere of any rotating black hole and eventually comes out of it safety, it also brings out some black hole energy with itself. This process is known as Penrose process.

QUASARS

Quasars are the one of the most astonishing and mind-boggling things of the universe. With size even smaller than any solar system they are much brighter than hundred and hundred galaxies together. Quasars are the most intense source of energy, the most powerful quasar have luminosities exceeding 10^{41} W, thousands of times greater than an ordinary large galaxy such as the Milky Way Galaxy.

And this demeanour of quasar makes it one of the most important part of universe.

In late 1950s, British astronomer John Bolton discovered first ever quasar-3C273. They were first noted as radio source with no corresponding visible light and mistaken as a faint blue star. Later on, John Bolton and Cyril Hazard done many measurements over its spectrum and found that these spectrums were completely different form spectrum of those normal stars.

How Quasars form?

When a super massive black hole start feeding it surrounding the result is Quasar.

A quasar is believed to be a supermassive black hole surrounded by an accretion disk. An accretion disk is a flat, disk-like structure of gas that rapidly spirals around large objects and when it comes under the influence of such massive black hole's gravity , they also starts rotating get polarised and form a plasma or may be cloud like structure and gradually the super massive black hole starts attracting these gases and sometimes other stars or even small galaxies, the result is a massive collision of matter that causes a gigantic explosive output of radiation energy and light, seen and termed by us Quasar.

Why Quasars are so different?

Quasars are really close to the limits of known universe, they are farthest object we have ever seen. There visible energy is immense and if we observe them with infrared, we see that their energy is even greater. Nearest quasar to us is 780 million light years far and the farthest one is 13000 million light year far at the edge of known universe. Our universe is 13700 million years old and this farthest quasar shows that it was present there when our universe was in its infancy, which make the study of quasars more interesting and important for astrophysicists.

As a biggest source of energy in universe it is also termed as Active Galactic Nucleus. The biggest known quasar devours 1000 solar masses of matter each year, nearly 2.7 solar masses of matter per day.

Summery

Though it is hard to understand universe but it is necessary to us because universe is under no obligation to make itself understand to us. As we know

every thing in this universe have come out of the same energy dot which exploded at the time of big bang, means before the big bang these galaxies, plants, sun, black holes even we all were in the same energy dot. With passage of time nearly 13700 million years we are finally here trying to find why our universe is like this only, trying to trace down the importance and nature of each and every element weather it is black hole or quasar or any non-visible energy.

In this paper I tried to sum up the basic information about the black hole and things present in its surrounding. This paper is more life an article over some most important phenomena of universe with basic information and data about them.

“Astronomy is useful because it raises us above ourselves. It is useful because it is grand, it shows us how small is man’s body, how great his mind. Since his intelligence can embrace the whole dazzling immensity where his body is only an obscure point. And enjoy its silent harmony.”- HENRI POINCARÉ.

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