IOSR Journal Of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 14, Issue 4 Ser. I (Jul. – Aug. 2022), PP 07-09
www.Iosrjournals.Org

Basics of Black Holes

J.M.KALYANI

Abstract
A black hole is a region of space-time exhibiting such strong gravitational effects that nothing not even particles and electromagnetic radiation such as light can escape from inside it. In many ways a black hole acts like an ideal black body, as it reflects no light. Black holes of stellar masses are expected to form when the massive stars collapse at the end of their life cycle. After a black hole has formed, it can continue to grow by absorbing mass from its surroundings. By absorbing other stars merging with other black holes, supermassive black holes of millions of solar masses may form There is general consensus that super massive black holes exist in the centre of most galaxies.

Key Words
Black holes, massive stars,galaxy, gravitational effects, light waves.

Date of Submission: 15-07-2022 Date of Acceptance: 31-07-2022

I. Introduction

A black hole is anything but empty space. Rather it is a great amount of matter packed into a very small area. Think of a star ten times more massive than the Sun squeezed into a sphere approximately the diameter of New York city. The result is a gravitational field so strong that nothing not even light can escape.

Most famously, black holes were predicted by Einstein's theory of general relativity, which showed that when a massive star dies, it leaves behind a small dense remnant core. If the core's mass is more than about three times the mass of the Sun, the equations showed the force of gravity overwhelms all other forces and produces a black hole.

Scientists can't directly observe black holes with telescopes that detect X-rays, light or other forms of electromagnetic radiation. We can however infer the presence of black holes and study them by detecting their effect on other matter nearby if a black hole passes through a cloud of interstellar matter, for example, it will draw matter inward in a process known as acceleration. A similar process can occur if a normal star passes close to a black hole. In this case a black hole can tear the star apart as it pulls towards itself. As the attracted matter accelerates and heats up, it emits X-rays that radiate into space. Recent discoveries offer some tantalizing evidence that black holes have a dramatic influence on the neighbourhoods around them emitting powerful Gamma ray bursts, devouring nearby stars and spurring the growth of new stars in some areas while stalling it on others.

II. Literature Survey

The idea of a body so massive that even light could not escape was briefly proposed by astronomical pioneer John Mitchell in a letter published in November1784. Mitchell's simplistic calculations assumed that such a body might have the same density as the sun, and concluded that such a body would form when a star's diameter exceeds the Sun's by a factor of 500 and the surface velocity exceeds the usual speed of light. Mitchell correctly noticed that such super massive but non-radiating bodies might be detectable there by gravitational effects on nearby visible bodies.

One of Stephen Hawking's most famous theorems has been proven right, using ripples in space-time caused by the merging of two distant black-holes. The black hole area theorem, which Hawking derived in 1971 from Einstein's theory of general relativity, states that it is impossible for the surface area of a black hole to decrease over time. According to the new study, a black hole's surface area is set out by a spherical boundary known as the event horizon – beyond this point nothing, not even light can escape its powerful gravitational pull. According to Hawking's interpretation of general relativity, as a black hole surface area increases with mass, and because no object thrown inside can exit, its surface area cannotdecrease. But a black hole surface area also shrinks the more it spins, so the researchers wondered whether it is possible to throw an object inside hard enough to make the black hole spin enough to decrease its area.

PROBLEM DEFINITION
How does a black hole form? One star ending is a black hole beginning.

III. Methodology

Most black holes form from the remnants of a large star that dies in a supernova explosion. If the total mass of the star is large enough (about three times the mass of the Sun) it can be proven theoretically that no force can keep the star from collapsing under the influence of gravity.However, as the star collapses a strange thing occurs. As the surface of the star nears an imaginary surface called the 'event horizon ', time on the star slows relative to the time kept by observers far away. When the surface reaches the event horizon, time stands still and the star can collapse no more – it is a frozen collapsing object.

Primordial black holes are thought to have formed in the early universe, soon after the big bang. Stellar black holes form when the centre of a very massive star collapses in upon itself. This collapse also causes a supernova, or an exploding star, that blasts part of the star into space.

Scientists think supermassive black holes formed at the same time as the galaxy they are in. The size of the supermassive black hole is related to the size and mass of the galaxy it is in.

TYPES OF BLACK HOLES

There are four types of black holes.Stellar,intermediate, supermassive and miniature. The most commonly known way a black hole forms is by stellar death. As stars reach the ends of their lives, most will inflate, lose mass and then cool to form white dwarfs. But the largest of these fiery bodies, those at 10 to 20 times as massive as our own sun, are destined to become either super – dense neutron stars or so called stellar – mass black holes. In their final stage,enormous stars go out with a bang in massive explosions known as supernovae. Such a burst flings star matter out into space but leaves behind the stellar core. While the star was alive, nuclear fusion created a constant outward push that balanced the inward pull of gravity from the stars own mass. In the stellar remnants of a supernova, however there are no longer forces to oppose that gravity, so the star core begins to collapse in on itself.

If its mass collapses into an infinitely small point, a black hole is formed. Packing all of that bulk, many times the mass of our own sun into a tiny point gives black holes their powerful gravitational pull. Thousands of these stellar – mass black holes may lurk within our own Milky Way galaxy.

An intermediate mass black hole is a class of black hole is a class of black hole with mass in the range of 10^2-10^5 solar masses-significantly more than stellar black holes but less than the $10^5 \sim 10^9$ solar mass supermassive black holes. As the name implies, intermediate mass black holes fall between stellar mass black holes and supermassive black holes. This type of black hole is not too small, not too big. But it is rare.

Intermediate black holes are particularly interesting because they may hold the key to understanding how these curious beings grow and evolve overtime. But these cosmic adolescents are shrouded in mystery, as they appear to be scarce throughout the universe.

A supermassive black hole is the largest type of black hole, with its mass being on the order of millions to billions of times the mass of the sun. Black holes form after a massive star runs out of fuel, sometimes resulting from a supernova and other times without a supernova, which is called the direct collapse scenario.

Once a star has no fuel left out to burn, it can no longer support its mass and collapses. Most galaxies, and may be all of them, harbor such a black hole.So, in our region of the universe, there are some 100 billion supermassive black holes.

Miniature black holes are called Micro black hole. Micro black holes also called mini black holes or quantum mechanical black holes are hypothetical tiny black holes, for which quantum mechanical effects play an important role. The concept that black holes may exist that are smaller than stellar mass was introduced in 1971 by Stephen Hawking. Miniature black holes may have formed immediately after the Big Bang. Rapidly expanding space may have squeezed some regions into tiny, dense black holes less massive than the sun. If a star passes too close to a black hole, the star can be torn apart.

IV. Results And Discussion

Black holes are a relatively interesting phenomenon in astronomy since a black hole is a region in space where the force of gravity is so strong such that light cannot escape from it. A black hole is ideally invisible since no light can escape, but scientists study them by observing the behaviour of adjacent stars using space telescopes. Due to the strong gravity that pulls the light towards the centre of the black hole, scientists study stars orbiting black holes since when stars and black holes are nearby high energy light is emitted which telescopes can visualize.

A black hole is effectively defined and identified from a general relativity standpoint. According to Mabkhout(2020) , a black hole is an object in space with a higher escape velocity beyond the speed of light . Considering Einstein s definitions of gravity is hinged on the curvature of spacetime, and in the event of a black hole, the centre of its curvature extends to infinity. Einstein s relativity implies that the density of matter in these regions is zero.

V. Conclusion

The Universe can be an unbelievably violent and extreme place . Nowhere is this seen more clearly than with the many exotic objects that can be found scattered throughout the Cosmos from transient stellar explosions to all consuming black holes .A black hole is a compact/localised region of space surrounding a collapsed mass within which gravity is so powerfull that neither matter nor radiation can escape – in other words , the escape velocity exceeds the velocity of light . A black hole is thought to have formed when a star with a certain mass undergoes total gravitational collapse .For a star with mass greater than M , gravity squashes the star to such an extent that ,in theory ,its density become infinite and its volume is zero . This state of matter is called ‘’singularity’’ and is inaccessible to the laws of physics as we understand them ,in other words it breaks the laws of physics . For a black hole to form the solar mass of the star has to be 3 times heavier than the sun . The gravitational field surrounding a black hole is so high that no radiation , including light can escape and as a result of this it appears black due to the absence of any observable emission .

FUTURE SCOPE

Black holes are some of the strongest and most fascinating objects found in the universe .While black holes are predictions of Einstein’s theory of gravity one hundred years ago ,even he did not imagine that such exotic objects could exist . Only recently , in 2019 , the first ever picture of a black hole has been made by the Event Horizon Telescope or EHT , the first direct proof of the existence of a black hole in the centre of the elliptical galaxy . It was ground breaking in many ways . 1. It presents the direct evidence for the existence of black holes , showing that Einstein and hence the theory of General Relativity was right . 2. It shows the first ever image of lensed and relativistic beamed emission on the scale of the event horizon in exremegravity . 3. And it helps to constrain models for jet formation and energy exraction from black holes . More observations are required to further constrain the models , to monitor the variations of the flow of matter in extreme conditions on different timescales and to image the black hole in the centre of our own galaxy .

REFERENCES :

[1]. Overbye,DENNIS (8 th June 2015) “Black Hole Hunteres” NASA
[2]. Hubblesite: Black Holes: Gravity’s relentless ull interactive Encycloperdia. ST SelHome, Retrieved May 6, 2022
[3]. NASA – Imagine the Universe Retrieved May 6, 2022
[4]. Bolen.B(2013,August 29) Supermassive Black hole Sagittarius A, NASA, Retrieved May6,2022
[5]. NASA’s Chandra finds intriguing Member of Black Hole family Tree Abbot, B.Pet al (2016) Phys. Rev. Lett. 116(6)
[6]. Event Horizon Telescope (2019). The shadow of a supermassive Black Hole. The Astrophysical Journal 815
[7]. Gardinar, Aidan (12th April 2018). A Black Hole finally reveals.
[8]. Astronomers captured the first image of a Black Hole. Archived from the original on 1st Jan 2022. Retrieved 15th April 2019.
[9]. Gardiner, Aidan (12th April 2018). When a Black Hole finally reveals itself New York Times 1st Jan 2022
[10]. Gass, Institute of Astronomy. Design by D.R.Wilkins “Light escaping from Black Holes” Archived from the original on 6th July 2019.

J.M.KALYANI. “Basics of Black Holes.” *IOSR Journal of Applied Physics (IOSR-JAP)*, 14(4), 2022, pp. 07-09.