GRAVITY LENSING FOR A BLACKHOLE

Nikkisha Subramanian, Labani Roy, Shruti, Nisha Yadav, Swasthi Shetty,

Aero.in Space Tech Pvt Ltd.

ABSTRACT

Gravitational lensing is a phenomenon that occurs due to the gravitational field of massive objects like black holes or galaxies, which causes the path of light to bend as it passes near them. By analysing the distorted images resulting from this phenomenon, researchers can infer all the detailing of the black hole and gain insights into their various characteristics based on the fundamental laws of physics and the evolution of galaxies.

This paper aims to explore the theoretical basis of gravitational lensing and examine recent observational studies that have utilized it to study black holes. By doing so, it highlights the significance of gravitational lensing as a powerful tool for studying black holes and deepening our understanding of their properties.

Keywords: black hole, gravitational lensing, space, time, light.

INTRODUCTION

Our universe is governed by four fundamental forces, with gravity being the weakest yet the most far-reaching force responsible for the orbits of planets and stars, as well as the structure of the universe on a large scale. The electromagnetic force is responsible for interactions between electrically charged particles, holding atoms and molecules together, and controlling the behaviour of light. The radio active decay result in weaker nuclear force, the atomic nuclear is held together by the greater nuclear forces, being strongest among the four fundamental forces with a very short range. Black holes, remnants of enormous stars that exploded as supernovae, warp space with their powerful gravitational pull, making it impossible to observe them directly. However, images of stars are distorted because of the warping of the universe surrounding the black hole, providing evidence that these solitary black holes are traversing our galaxy. Gravitational lensing is a technique used to detect black holes by bending the light of background stars, making it conceivable to study dormant black holes in faraway galaxies and identify others black holes and exo planets.

By the methode of gravitational lensing, scientist are able to identify the presence of ultra massive black hole, which does not allow light to escape due to stronger gravity, as a near by galaxy is being use as magnifing glass. This method could potentially enable the discovery of numerous additional black hole other then those are there in the global universe and show up how the unusual phenomena introduce in the cosmic era. Gravitational lensing was first predicted by Einstein in 1919 through his theory of relativity, which determines the light bending caused by the space time curvature caused by massive celestial bodies. This phenomenon has led to remarkable discoveries, particularly in the study of black holes, including the detection of the first black hole merger in 2016 using direct detection of gravitational waves.

As far the black holes are known found in active state, emitting radiation due to pulling action of matters as it comes close to the black hole,this produces heat energy is released which forms lights and x-ray. Gravitational lensing, though, it becomes possible to studying the black holes which are inactive, which are currently not detectable in far away galaxies, and can provide new insights into the physics of distant supermassive black holes.

LITERATURE REVIEW

1. Benjamin C. Bromley (et.al,1997) - This article explores the rotating black hole which is surrounded by an accretion disk and hotspot rotating together in search of potential indicators of the frame-dragging effect.
2. Joachim Wambsganss (et al., 1998) - This review provides a detailing to the theory of gravitational lensing and its observational and astrophysical implications, including microlensing and time delay effects.
3. Julian H. Krolik (et.al,2002) - The paper discusses the four non-axisymmetric, time-variable, and accretion rate-dependent "inner edges" of black hole surrounded by an accretion disk.
4. Kris Beckwith (et.al, 2005) - This article reviews a radial velocity survey of extrasolar planets and emphasizes the importance of accurately determining their masses and orbits.
5. V Bozza (et.al, 2007) - The paper extends previous work on gravitational lensing, focusing on the black hoes with the source of strong deflection limit located at arbitrary distance.
6. Kendrick M. Smith (et.al,2009) - The paper discusses the scientific justification for CMB lensing in polarization, taking into consideration limitations on cosmic parameters, greater B-mode gravity wave sensitivity via reconstruction of lens,anticipated non-CMB Contamination and necessary beam systamatic management.
7. Joan Centrella (et.al, 2010) - The paper discusses a black hole binary by final merger dynamics the final merger dynamics and gravitational radiation.
8. Valerio Bozza (et.al, 2010) - The article explores the possibility of black holes and wormholes in the context of dark energy and summarizes previous research on the effects of dark energy on evolution and formation of black hole and wormholes.
9. Changbom Park (et al 2012) - The article begins with an explanation of the current state of cosmology and the observational evidence for the universe structure and explores proposed solutions to theoretical challenges posed by the observed large-scale structures.
10. B.P.Abbott (et.al, 2016) - The paper discusses the detection of gravitational waves with merger of black hole observed by LIGO, this waveform mainly predicted in General Relativity and the ringdown of the resulting single black hole.
11. Ely D Kovetz (et.al, 2017) - The paper discusses the observation of future gravitational wave measurements from merging black holes and uses numerical simulations to investigate the evolution and formation of black holes and their host galaxies
12. . Bobir Toshmatov (et al., 2017) - Provides a theoretical analysis of the effects of plasma on gravitational lensing by regular black holes and highlights the potential using observed lensing properties to constrain properties of the black hole and plasma environment.
13. C. R. Keeton (et al., 2018) - Examines the time delay effects of black holes using gravitational lensing and their singularities and shows how these effects depend on the properties of the lens and the observer.
14. Samuel E. Gralla (et al., 2020) - Presents a study of the black hole, which determines the shape of photon ring, which can be used to test strong-field general relativity.
15. Hongsheng Zhang (et al., 2021) - Investigates the impact of an additional term on the size of black holes shadow and provides a important contribution to the study of strong gravitational lensing and the effects of dark energy on black hole metrics.
16. James Paynter (et.al, 2021) - Reviews the search for intermediate-mass black holes (IMBHs) and the use of gravitational lensing to detect them, and discusses the potential implications for our understanding of galaxy formation and evolution.
17. Guillaume Mahler(et.al,2022) - Investigates in galaxy clusters of the gravitational lensing effects of SMBHs and the detectable traces of SMBHs image configurations with the help of higher order strong lensing.
18. Aviad Levis(et.al,2022) - Discusses a new tomography technique called BH-NeRF that recover the continuous 3D emission by using gravitational lensing field close to a black hole.

19. Shinsuke Kawai et.al (2023) - Analyzes the Primordial Black Holes formation and the gravitational waves generation using models of cosmology and their detectability in gravitational wave observatories of future ground base and space borne.
20. Mingzhi Wang et.al (2022) - Reviews the formation and calculation shadow of black hole and discusses shadow of Schwarzschild black hole, photon motion systems in BH spacetime, and Lyapunov orbits near fixed points.

BLACKHOLE SHAPE

A black hole is a space region with gravitational pull is that much strong that light also can not escape. The shape of a black hole is determined by its event horizon, it is mainly boundary around of the black hole in that place nothing can be escape. According to the theory of general relativity, the event horizon is perfectly spherical and it is als non rotating black hole. However, if a black hole rotates, the event horizon is predicted to become oblate or flattened, similar to the shape of a slightly squashed ball. The degree of flattening speed dependent of the rotation of black hole.

It's important to note that this event horizon mainly critical feature of a black hole, but it's not the physical object itself. The black hole itself is a singularity, a point of infinitely dense matter at the centre of the event horizon where the laws of physics as we know them break down. Therefore, we cannot directly observe the shape of a black hole itself, but rather we infer its shape from the behaviour of matter and light around it. Through a small experiment, we can try to calculate the shape of a black hole by using gravitational lensing. If there are three gravitational lenses located at 60 degrees from each other and they are all aligned with the black hole at the centre, then the light passing through this system would be gravitational lensed multiple times. Each gravitational lens would bend the path of light, causing multiple images of the same background source to be produced. The number of images and their positions would depend on the exact geometry of the system and the mass and distance of the lenses from the source and observer.

It is unlikely that the experiment described would be able to directly determine of a black hole shape. The gravitational lensing effect of a black hole would be highly dependent on its mass, spin, and the geometry of the system, and observations of the gravitational lensing effects of black holes in different systems can gives important information about the black hole properties. If a black hole were to have a non-spherical shape, it could indicate the presence of external gravitational or tidal forces that are distorting the shape of the black hole. This could include the gravitational influence of other nearby massive objects or the effects of rotation or accretion. In addition, a non-spherical black hole could have different gravitational lensing effects compared to a perfectly spherical black hole. This could complicate the efforts to use gravitational lensing to study the properties of black holes or the distribution of matter in the universe.

Overall, a non-spherical black hole would be an interesting and unexpected discovery that, new insights is provide into the nature of these enigmatic objects. It could be a sign of 4-dimensional space in the universe, and its discovery could help us understand the universe's mysteries better.

ACCRETION DISK

As matter approaches a black hole, it does not simply fall into it. Instead, a thin, rotating disk is forms its called an accretion disc. This disk is made up of gas, plasma, and dust particles that spiral inward towards the black hole, losing energy and angular momentum is use. The particles in the disc are propelled to high speeds by the black hole's gravity, producing heat, X-rays, and gamma rays. Depending on our viewpoint, the accretion disc can appear flattened, elliptical, or circular in shape. The strong gravitational force of the black hole also causes the light arriving from different regions of the disc to bend and distort. This effect is greatest when viewing the system almost edge-on. The relativistic Doppler beaming phenomenon makes one side of the disc appear brighter while the other side appears darker, but this effect disappears when our viewpoint is above or below the disc. As the gas in the disc heats up and emits radiation, the accretion disc becomes an important tool for studying and understanding black holes.

BLACKHOLE SPIN

Black holes are fascinating objects in the universe that have long captured the interest of scientists and the public alike. The study of black holes is important for understanding the fundamental properties of gravity, the structure of the universe, and the evolution of galaxies. One of the critical properties of a black hole is its spin, which is a measure of how fast it is rotating around its axis.

The spinning of a black hole can be inferred by studying the motion of matter around it and analysing the properties of the light emitted by this matter. This light is affected by gravitational lensing, which is the bending of light using of gravitational field of the massive objects. As light passes through the curved spacetime near a spinning black hole, it can be affected by the rotation of the black hole. This phenomenon is known as frame dragging, and it can create a net torque on the black hole, causing it to spin faster or slower depending on the direction of the gravitational lensing torque.

The lensing light emitted by matter orbiting a spinning black hole can also be affected by the black hole's spin, leading to characteristic patterns in the observed radiation that can gives information about the spinning of the black hole. These asymmetries in the observed lensing patterns can be used to infer the orientation axis of the black hole's spin. By observing how the light is distorted as it passes through the gravitational field, astronomers can determine the amount and direction of the spin of the black hole.

Studying the effect of gravitational lensing on the black hole spinning is important for understanding the dynamics of black holes and their interaction with matter in their vicinity. Using of the gravitational lensing in the hunt for gravitational waves is also essential because it can provide researchers with a sight into the intense gravity of black holes or stars, which they can also use to look for the distinctive ripples in spacetime that would indicate the passage of these elusive waves.

Overall, the effect of gravitational lensing on the spinning of the black hole is an important factor to consider when studying these objects and understanding their properties. Gravitational lensing can provide valuable information about the dynamics of black holes and their interaction with matter in their vicinity, and advances in observational and theoretical techniques are enabling us to gain new insights into these fascinating objects. The study of gravitational lensing has expanded our knowledge of the universe and holds enormous promise for more discoveries to come.

GRAVITATIONAL WAVE

It is mainly the merger of the black hole. Gravitational wave was detected by LIGO. Using Laser interferometer try to observed gravitational wave. Placing four mirrors in four directions centring a black hole in between. Laser light are being projected on all the four mirrors. As the laser light reflect, comes back in same time and merges in the centre at the same time. This produces more energy and creation of waves takes place in bulk. And we observed two black holes create gravitational wave - when two massive black hole comes too close to each other. Starts to revolve around each other, And by time both mergers. This produces more energy and creates greater repulsive waves in conjunction to greater energy. In comparison Rathore then two massive black holes, if too small black hole come closer and merges, this will be resulting less energy and wave production as well.

Overall, the methodology for studying gravitational lensing in black hole involves the combination of theories, prefer some research papers to grain better understanding of the properties and behaviour of this enigmatic object.

CONCLUSION

In this review, the formation of black holes using gravitational lensing was briefly discussed, and several important observations were made. For example, it was noted that experiments can determine the shape of a black hole directly, providing valuable information for astrophysics and cosmology. The review also examined the significance of various physical parameters, those are black hole mass, spin, and accretion rate, in shaping the lensing signatures of these objects. Overall, the review highlighted the importance of gravitational lensing as a tool for exploring the fundamental properties of black holes and gaining new insights into these fascinating objects. Additionally, the use of gravitational lensing in the search for gravitational waves is critical, as it can help researchers detect the elusive ripples in spacetime that indicate the passage of these waves. The study of gravitational lensing has significantly expanded our understanding of the universe and has the potential to uncover many more discoveries in the future.

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