



## Black hole in space 2020

## What's black hole in space. Is there a black hole in space. What is the black hole in space called.

The compact astrophysical object with such strong gravity nothing can escape for other uses, see the black hole (disambiguation). Animated simulation of a black hole in Schwarzschild with a galaxy that passes behind in a perpendicular plane to the line of sight. Around and at the time of exact alignment (Syzygy), it is observed extreme gravitational of the galaxy from the black hole. General Relatity G 1/4 1/2 + 1/4 1/2from it. [1] General relativity theory predicts that a sufficiently compact mass can deform the countytime to form a black hole. [2] [3] The border of no escape is called the horizon of the event. Although it has a huge effect on the fate and circumstances of an object that crosses it, according to general relativity it has no detectable characteristics locally. [4] In many ways, a black hole acts as an ideal black body, as it does not reflect light. [5] [6] In addition, the quantum field theory in curved spacetime predicts that the horizons of events emit Hawking radiation, with the same spectrum as a black body of an inversely proportional temperature to its mass. This temperature is in the order of billions of a kelvin for the black holes of the stellar mass, making it substantially impossible to observe directly. Objects whose gravitational fields are too strong for escape light were taken into account in the 18th century by John Michell and Pierre-Simon Laplace. [7] The first modern solution of general relativity that would characterize a black hole was found by Karl Schwarzschild in 1916 and his interpretation as a region of space from Which nothing can escape from David Finkelstein in 1958. Black holes were long considered a mathematical curiosity; It was not until the 1960s that theoretical work showed that they are a generic prediction of general relativity. The discovery of the neutron stars of Jocelyn Bell Burnell in 1967 sparked interest in compact objects that had collapsed as a possible astrophysical reality. The first black hole known as this was Cygnus X-1, identified by several researchers independently in 1971. [8] [9] The black holes of the stellar mass form when the very massive stars collapse at the end of the life cycle. After a black hole has formed, it can continue to grow by absorbing the mass from its surroundings. Absorbing other stars and melting with other black holes, supermassive black hol through its interaction with other materials and with electromagnetic radiation like visible light. The matter on which falls fallsThe black hole can be destroyed by streamer that shines very brilliantly before being "swallowed". [10] If there are other stars that orbit a black hole, their orbits can be used to determine the mass and the position of the black hole. These observations can be used to exclude possible alternatives such as neutron stars. In this way, astronomers have identified numerous candidates for stellar black holes in binary systems and established that the radio source known as Sagittarius a \*, to the core of the Milky Way Galaxy, contains a supermessive black hole of about 4.3 million masses Solari. On 11 February 2016, the Scientific Collaboration Ligo and the collaboration of the Virgin announced the first direct detection of gravitational waves, which also represented the first observation of a fusion of black holes. [11] Starting from December 2018 [update], eleven events of the gravitational wave were observed that originated from ten fusion of black holes (together with a neutron binary merger). [12] [13] On 10 April 2019 the first direct image of a black hole and its proximity and its vicinity was published, following the observations made by the Horizon Telescope event (EHT) in 2017 of the supermed black hole in Galactic center of Messier 87 [14] [15] [16] In March 2021, the collaboration EHT presented, for the first time, a polarized image of the black hole that can help to better reveal forces giving rise to Quasar. [17] The supermassive black hole to the core of the supergiant Messier 87 elliptical galaxy, with a mass of about 7 billion times compared to that of the sun, [18] as depicted in the first false color image in the radio waves published by the Horizon event Telescope (10 April 2019). [19] [14] [20] [21] Visible is the crescent-shaped emission ring and the central shadow, [22] which are gravitantly enlarged views on the photonic ring of the black hole and the capture area of the photon of his horizon of the event. The half-moon shape rises from the relativistic ragazione; The shadow is about 2.6 times the diameter of the horizon of the event. [14] The cloud of gas was torn from black hole at the center of the Milky Way (the 2006 comments, 2010 and 2013 are shown in blue, green and red, respectively). [23] Starting from 2021 [Update], the nearest well-known body could be a black hole is about 1500 years of light (see list of closest black holes). Although only a dozen black holes have been found so far in the Milky Way, we have thought of being hundreds of millions, most of which are solitary and do not cause radiation issue, [24], so it would only be detectable for lenses gravitational. History Simulated views. On the other side of the top, the milky disk appears distorted in a bow. The idea of a body so massive that even the light could not escape was briefly proposed by an English astronomical pioneer and the clergy of John Michell in a letter published in November 1784. The simplistic calculations of Michell assumed such a body They could have the same density of the sun, and concluded this is formed when the diameter of a star exceeds the sun of a factor 500, and its superficial escape speed exceeds the usual speed of light. Michell refused these bodies [7] [26] [27] Time scholars were initially enthusiastic from the proposal that the "dark stars" giants but invisible could hide in a simple view, but the enthusiasm is damped when the nature wavelke of light became evident in the first Years of the nineteenth century, [28] as if they were a light wave rather than a particle, it was not clear what, if someone, influences the gravity would have on an escape escape light Modern physical discredit The notion of Michell of a light ray that fires directly from the star, stopping, and then free fall to the surface of the star. [29] General relativity See also: History of general relativity in 1915, Albert Einstein developed its general relativity theory, having shown previously that gravity influences the movement of light. Only a few months later, Karl Schwarzschild found a solution to Einstein's field equations, which describes the gravitational field of a point mass and a spherical mass. [30] A few months after Schwarzschild, Johannes Droste, a student from Hendrik Lorentz, independently gave the same solution for the point mass and wrote more widely on his properties. [31] [32] This solution had a particular behavior in what is now called the Schwarzschild radius, where it has become unique, which means that some of the terms in Einstein equations have become infinite. The nature of this surface was not well understood at the moment. In 1924, Arthur Eddington showed that the singularity disappeared after a coordinate change (see Eddington-Finkelstein coordinates), although it took place until 1933 for Georges LemaÃ. Tre to realize that this meant the singularity at the radius of Schwarzschild was a singularity of non-physical coordinates. [33] Arthur Eddington has however commented on the possibility of a star with a compressed mass at the radius of Schwarzschild in a book from 1926, noticing that Einstein's theory allows us to exclude excessively large density for the stars visible as betelgeuse because "a star of 250 million km of radius could not have so high density like the sun. Firstly, the gravitation force would be so great that the light would not be able to escape from it, the rays that fall to the star like one stone to the ground. Secondly, the ray sthat fall to the star like one stone to the ground. the space metric that the space would approach around the Star, leaving us out (ie, anywhere). "[34] [35] In 1931, Subrah Manyan Chandrasekhar calculated, using special relativity, which a non-rotating body of the subject Tron-degenerated above a certain limiting mass (now called Chandrasekhar limit solutions at 1.4 mâ~
‰). [36] The arguments of him were contrary to many of his contemporaries like Eddington and Lev Ledau, who claimed that some mechanisms still unknown would stop the collapse in a star of neutrons, [38] which is of a stable sà ©. But in 1939, Robert Oppenheimer and others predited that neutron stars over another limit (Tolman-Oppenheimer-Volkoff's limit) would have collapsed further for the reasons presented by Chandrasekhar, and concluded that no physics law would be likely to intervene and Stop at least a few stars from collapse to black holes. [39] Their original calculations, based on the principle of exclusion of Pauli, gave it as 0.7 mâ € ‰; Next consideration of the strong Neutroni-Neutron increased the estimate at about 1.5 mâ € ‰ at 3.0 mâ € ‰. [40] The observations of the Star Merger of Neutroni GW170817, which one thinks has generated a black hole shortly afterwards, have refined the Tov limit estimate at ~ 2.17 mâ € . [41] [42] [44] [45] Oppenheimer and its co-authors interpreted the singularity on the border of the Schwarzschild radius as indicating that this was the limit of a bubble in which time has stopped. This is a valid point of view for external observers, but not for infallible observers. Because of this property, Falling stars were called "frozen stars", because an external observer would see the surface of the frozen star in time when its collapse leads it to the Schwarzschild as an event" A perfect unidirectional membrane: causal influences can cross it in one direction." [47] This has not strictly contradicted the results of Oppenheimer, but extended it to include the point of view of the infallitive observers. Finkelstein's solution extended the Schwarzschild solution for the future of observers falling into a black hole. A complete extension was already found by Martin Kruskal, who was invited to publish it. [48] These results arrived at the beginning of the golden age of general relativity, which was marked by general relativity and black holes that become mainstream research subjects. This process was helped by the discovery of Jocelyn Bell Burnell's Pulsars in 1967, [49] [50] which, in 1969, would have proved to rotate neutron stars quickly. [51] Until then, the stars of neutron, like black holes, were considered only theoretical curiosity; But the discovery of PULSARS showed their physical relevance and pushed further interest in all types of compact objects that could be formed by gravitational collapse. They were found [Required quote] More general black hole solutions have been found at this time. In 1963, Roy Kerr found the exact solution for a rotating black hole. Two years later, Ezra Newman found the asymmetrical solution for a black hole that is both rotating and electrically loaded. [52] Through the work of Werner Israel, [53] Brandon Carter, [54] [55] and David Robinson [56] theorem without hair emerged, stating that a stationary solution of the black hole is completely described by the three parameters of the kerrâ E "Newman's Metric: mass, angular momentum and electric charge. [57] At first, it was suspected that the singularities will not fit in generic situations. This vision was held in particular by Vladimir Belinsky, Isaak Khalatnikov and Evgeny Lifshitz, who tried to prove that they do not appear singular in generic solutions. However, at the end of the 1960s, Roger Penrose [58] and Stephen Hawking used global techniques to prove that singularities appear generically. [59] For this job, Penrose received half the 2020 Nobel Prize in Physics, hawking having died in 2018. [60] Based on observations in Greenwich and Toronto in the early 1970s, Cygnus X-1, a galactic X-ray source discovered in 1964, became the first commonly accepted astronomical object to be a black hole. [61] [62] Works by James Bardeen, Jacob Bekenstein, Carter and Hawking in the early 1970s led to the formulation of the thermodynamics of the black hole. [63] These laws describe the behaviour of a black hole in the close analogy to the surface to the temperature. The analogy was completed when Hawking, in 1974, demonstrated that quantum field theory implies that black holes should radiate as a black body with a temperature proportional to the severity of the surface of the black hole, predicting the effect now known as Hawking radiation. [64] Etymology John Michell used the term "Dark Star", [65] and at the beginning of the 20th century, the physicists used the term " gravitational collapsed object". Science Writer Marcia Bartusiak Tracks the term "black hole" to the physicist Robert H. Dicke, who in the press by magazines of news about life and science in 1963, [66] and by the journalist of scienceEwing in his article "black holes in space" of 18 January 1964, which was a report on An American Association meeting for the progress of science Hold in Cleveland, Ohio. [67] [68] In December 1967, a student suggested that a student suggested the phrase "black hole" in a John Wheeler lesson; [67] Wheeler adopted the term for its brevity and "advertising value", and quickly captured, [69] leading some to Wheeler with Coining the phrase. [70] [70] and simple structure illustration of a black hole not sputting the no-haired theorem postulates that, once a stable condition after training, a black hole has only three independent physical properties: mass, electric charge and angular momentum; The black hole is otherwise without characteristic. If the conjecture is true, any two black holes under the laws of modern physics is currently an unresolved problem. [57] These properties are special because they are visible from outside a black hole rejects more accusations like any other loaded object. Similarly, the total mass within a sphere containing a black hole can be found using the gravitational analogue of the Gauss Law (through the mass of ADM), far from the black hole. [71] In the same way, the angular moment (or rotation) can be measured from afar by using the drawing frame from the shape of the object or charge distribution on it is uniformly distributed along the horizon of the black hole, and is lost to external observers. The behavior of the horizon in this situation is a dissipative system that is strictly similar to that of a conductive elastic membrane with friction and electrical resistance  $\hat{\epsilon}$  "the membrane paradigm. [73] This is different from other field theories such as electromagnetism, which have no friction or microscopic resistance, because they are reversible over time. Because a black hole finally reaches a stable state with only three parameters, there is no way to avoid losing information on the initial conditions: the gravitational and electrical fields of a black hole give very few information on what has gone in. Lost information includes any quantity that cannot be measured away from the black hole horizon, including quantum numbers approximately preserved as the total number of Baroon and the number of Leptons. This behavior is so disconcerting that it was called the paradox of information loss of black hole [74] [75] Distaction of gravitational time around a black holes are often indicated as Schwarzschild black holes after Karl Schwarzschild black holes are often indicated as Schwarzschild black holes after Karl Schwarzschild black holes after K solution that is a spherical symmetrical. [76] This means that there is no difference observable at a distance between the gravitational field of such a black hole and that of any other spherical object of the same mass. The popular notion of a black hole "suck in all" in its surroundings is therefore correct only near the horizon of a black hole; Far away, the external gravitational field is identical to that of any other body of the same mass. [77] There are also solutions that described by the reissner-Nordström metric, while the Kerr metric describes a non-loaded rotating black hole. The solution PIA 1 for general stationary blacks holes note  $\tilde{A}$  i the Kerr-Newman metric, which describes a black hole with charge and angular momentum. [78] While the mass of a black hole can take any positive value, the charge and angular momentum. [78] While the mass. The total electric charge Q and the total amount of angular momentum J are expected to satisfy Q 2 4  $\hat{\mu}$  i 0 + c 2 J 2 2  $\hat{a}$  × GM GM 2 {\ displaystyle {\ frac {Q ^ {2}} { 4 000 \_ {0}}} + {frac {c ^ {2} j ^ {2}} {gm ^ {2}} leq gm ^ {2}} leq gm ^ {2}} for a black hole mass m. Holes blacks with the mass possible that satisfies this inequality are called extremes. There are solutions of Einstein's equations that violate this inequality, butThey do not have a horizon of events. These solutions have so-called naked singularity that can be observed from the outside, and are therefore considered infisiche. The cosmic censorship hypothesis rules out the formation of such singularities, when they are created through the gravitational collapse of realistic matter. [2] This is supported by numerical simulations. [79] Because of the relatively large strength of the electromagnetic force, the blacks holes that form from the collapse of stars are expected to retain the nearly neutral charge of the star. The rotation, however, should be a universal feature of compact astrophysical objects. The black-hole candidate binary X-ray source GRS 1915 + 105 [80] it appears to have an angular momentum near the maximum allowed value. That limit is not loaded [81] J â × GM 2 c, {\ displaystyle J \ leq {\ frac {GM ^ {2}} } \ leq 1. [81] [Note 1] Classification of black hole black hole class Approx.mass Approx.radius supermassico 105-1010 Mâ 0.001A 400 AU black hole intermediate-mass 103 Mâ 103 km â Rearth stellar black hole are commonly classified according to their mass, independent of the angular momentum, J. the size of a black hole, as determined by the radius of the event horizon, or Schwarzschild radius , is proportional to the mass, M, through rs 2 = c 2 â GM
{M {M} \_ {\ odot)}} ~ \ mathrm {km}} where rs is the Schwarzschild radius and Mâ is the mass of the sun. [83] For a black hole with nonzero spin and / or electric charge, the radius is smaller, [Note 2] until an extreme black hole event horizon could have a close [84] r = G + M c 2. {\Displaystyle r {\mathrm {+}} = {\frac {GM} {c^ {2}}}. Main article: Event horizon Far away from the black hole a particle can move in any direction, as shown by the set of arrows. It is only limited by the speed of light. Closer to the black hole spacetime starts to deform. There are more paths going towards the black hole that the paths that move. [Note 3] Inside the event horizon, all paths bring the particle closer to the center of the black hole. It is no longer possible to escape the particle closer to the center of a black hole is the appearance of a horizon of events â a boundary in spacetime through which matter and light can only pass to the mass of the black hole. Nothing, not even light, can escape from inside the event horizon. [86] [87] The event horizon is identified as such because © if an event occurred. [88] As predicted by general relativity, the presence of a mass deforms spacetime in such a way that the paths taken by particles bend towards the mass. [89] of the event horizon of a black hole, this deformation becomes so strong that there are no paths that lead away from the black hole. [90] To a distant observer, clocks near a black hole appear to tick more slowly than those further away from the black hole. [91] Because of this effect, known as gravitational time dilation, an object falling into a black hole appears to slow down, from the point of view of a fixed external observer, causing any light emitted from the object to appear redness and dimmer, an effect known as gravitational redshift. [93] Eventually, the falling object that disappears from sight within less than a second. [94] On the other hand, the indestructible observers who fall into a black hole do not makequalsiasi di questi effetti mentre attraversano l'orizzonte degli eventi. Secondo i loro orologi, che sembrano loro di spuntare normally, attraversano l'orizzonte deglii dopo un tempo finito senza notare alcun behavior singolare; nella relatività generale classica, è impossibile determine la posizione dell'orizzonte degli eventi di un buco nero in equilibrio è always sferica, mentre per i buchi neri rotanti l'orizzonte dell'evento è precisely sferica, mentre per i buchi neri rotanti l'orizzonte dell'evento è precisely sferica. [Note 4] [99] Per i buchi neri non rotanti (statici) la geometry dell'orizzonte dell'evento è precisely sferica, mentre per i buchi neri non rotanti l'orizzonte dell'evento è precisely sferica. centro di un buco nero, come descritto dalla relatività generale, può trovarsi una singolarità gravitazionale, una regione in cui la curvatura spaziale diventa infinite. [103] Per un buco nero non rotante, questa regione la forma di un singolo punto e per un buco nero rotante, si fa sprofondare per formare un anello singolarità che se trova nel piano di rotazione.[104] In entrambi i casi, la singolare regione ha volume zero. Si può anche dimostrare che la singolare regione contiene tutta la mas della soluzione buco nero. [105] La regione singolare può così essare considerata come una densità infinite. [106] Gli osservatori che cadono in un buco nero di Schwarzschild (cioè, non rotanti e non caricati) non podeno avoide di essere portati nella singolarità una volta che attraversano l'orizzonte dell'evento. Essi canno prolungare l'esperienza accelerando via per rallentare la loro mas viene aggiunta al totale del buco nero. Prima che ciò accada, essi saranno stati strappati dalle Crescenti forze di marea in un process a volta indicato come spaghettification o "effetto noodle".[108] Nel caso di un carico (Reissner-Nordström) o rotante (Kerr) buco nero, è possibile avoide la singolarità. Extend queste soluzioni per as possibile rivela l'ipotetica possibilità di uscire dal buco nero in un tempo di spazio diverso con il buco nero che agisce come un wormhole. [109] La possibilità di viaggiare in un altro universe è, tuttavia, theoric soil poiché qualsiasi disturbzione avrebbe distrutto questa possibilità.[110] Sembra anche possibile followe curve temporali chiuse (ritorno al proprio passeto) intorno alla singolarità del Kerr, che porta problematic Ad oggi, non è stato possibile combinare gli effetti quantici e gravitazionali in una singola theory, anche se esistono tentativi di formulare una tale theory della gravità guantistica. It is generally predicted che una tale theory della gravità guantistica. It is generally predicted che una tale theory della gravità guantistica. It is generally predicted che una tale theory della gravità guantistica. spessore zero in cui i photoni che si muovono sui tangenti a quella sfera sarebbero intrappolati in un'orbita circuslare sul buco nero. Per i buchi neri non rotanti, la sfera fotonica ha un raggio di 1.5 volta il raggio di 1.5 vo caduta, causerebbe un'instabilità che growebbe nel tempo, the imposing il photone su una traiettoria esterna che lo fa fuggire dal buco nero, the su una spirale internal dove allorizzoblack hole. So each light that reaches an external observer from the photonic sphere must have been issued by objects between the photonic sphere and the horizon events. [116] For a kerr black hole the beam of the photonic orbit, which can be program (the photonic orbit, where objects cannot remain in place. [119] The rotating black holes are surrounded by a region of spacetime in which it is impossible to stand still, called the ergosphere. This is the result of a process known as Frame-Dragging; The general relativity provides that any rotating mass tenders to "drag" slightly along the space immediately surrounding. Any object near the rotating mass will tend to move in the direction of rotation. For a rotating black hole, this effect is so strong near the horizon of the events of the black hole and from the ergosurface, which coincides with the horizon of events to the poles but is at a much greater distance around the equator. [119] Objects and radiation can escape normally from the ergosphere. Through the penous process, objects can emerge from the ergosphere with more energy than they have entered. Extra energy is taken from the rotational energy of the black hole. The rotation of the black hole slows down. [121] A variation in the penus process in the presence of strong magnetic fields, the Blandford-Znajek process is considered a probable mechanism for the enormous brightness and relativistic quasar jets and other active galactic nuclei. More stable circular orbit (ISCO) Main article: more stable circular orbit in Newtonian gravity, the test particles can permanently orbid at arbitrary distances from a central object. In general relativity, however, there is a more stable circular orbit (often called ISCO), within which, any infinitesimal disturbance to a circular orbit will lead to inhale in the black hole. [122] The position of the ICO depends on the rotation of the black hole, in the case of a black Schwarzschild hole (spin zero) is: R ISC GMO = 3 R = 6}} Einstein itself mistakenly thought that black holes were not formed, Because he believed that the angular moment of the particles that collapsed stabilized their movement in a certain ray. of general relativity to reject all the results on the contrary for many years. However, a minority of relativists continued to argue that black holes were physical objects, [125] and at the end of the 1960s, had persuaded the majority of researchers in the field that there is no obstacle to the formation of an event horizon. [Necessary quote] Simulation of two black holes that collide penrose has shown that once a horizon of form events, general relativity without quantum mechanics requires that a singularity will form inside. [58] Shortly thereafter, Hawking showed that many cosmological solutions describing the Big Bang have singularity without scalar camps or other exotic subjects (see "Penrose-Hawking singularities"). The Kerr solution, the NO-HAIR theorem, and the laws of the thermodynamics of the black holes are formed by the gravitational collapse of heavy objects such as stars but can also in theory be formed by other processes. [127] [128] Main article: gravitational collapse Gravitational collapse occurs when the internal pressure of an object. For stars this usually occurs either because a star has a "combustible" too small to maintain its temperature through stellar nucleosynthesis, or because a star that would be stable receives the extra matter in a way that does not lift its internal temperature. In both cases the temperature of the star is no longer high enough to prevent the collapse under its own weight. [129] The collapse can be stopped by the pressure of the star is no longer high enough to prevent the collapse under its own weight. the condensation of matter in a more dense exotic state. The result is one of the various types of compact star. What kind of forms depend on the mass of the original star residue left if the outer layers were wiped away (for example, in a type II supernova). The mass of the residue, the collapsed object that survives the explosion can be substantially lower than the original star. The remains above 5 mâ ~ are produced by stars that were over 20 mâ ~ before the collapse. [129] If the mass of the residue exceeds about 3 ... 4â m 5 w % (the tolmanâ e "Oppenheimer" Volkoff Limit [39]), either because the original star was very heavy or because the residual collected further mass through the increase of matter, Neutron degeneration pressure is also insufficient to stop collapse. No known mechanism (except for quark degeneration pressure, see Quark Star) is powerful enough to stop implosion and the object will inevitably collapse to form a black hole. [129] The impression of the supermax black
hole seed artist [130] the gravitational collapse of the heavy stars is assumed to be responsible for the formation of stars, which on their collapse would have produced black holes could be the seeds of supermassive black holes found in the centers of most galaxies. [131] It was further suggested that massive black holes with typical masses of ~ 105 mâ ~ could have formed from the direct collapse of the gas clouds in the young universe. [127] These huge objects were proposed as the seeds that eventually formulated the first quasars already observed at redshift z 1/4 7 {\displaystyle z \ sim 7} [132] Some candidates for such objects were found in the observational collapse is emitted very quickly, an external observer does not actually see the end of this process. Although the collapse is emitted very quickly, an external observer does not actually see the end of this process. infallible matter, a distant observer would see the slow-falled material and stood just above the horizon of the event, due to the expansion of gravitational time. Light from the collapsed material takes longer and longer to reach the observer, with the light emitted just before the event horizon modules delayed an infinite amount of time. So the external observer never sees the formation of the event; Instead, the collapsing material seems to become dimmer and increasingly reddish moved, eventually disappear. [133] The primordial black holes and the Big Bang gravitational collapse requires a large density. In the current epoch of the universe these high density are found only in the stars, but in the Universe shortly after the big bang density were much larger, possibly allowing the creation of black holes. The only high density density is not enough to allow the mass to group. For the primordial black holes formed in a half-thick half, there must have been Perturbations of density that could then grow under their own gravity. Several models for the primitive universe vary widely into their predictions of the scale of these fluctuations. Various models for the primitive universe vary widely into their predictions of the scale of these fluctuations. Various models for the primitive universe vary widely into their predictions of the scale of these fluctuations. Various models for the primitive universe vary widely into their predictions of the scale of these fluctuations. Various models for the primitive universe vary widely into their predictions of the scale of these fluctuations. hundreds of thousands of solar masses. [128] Although the primitive universe is extremely dense, much more dense than it is usually necessary to form a black hole, it has not re-connected in a black hole during the Big Bang. The models for the gravitational collapse of relatively constant objects, such as the stars, do not necessarily apply the same way to quickly expand space as the Big Bang. [134] Event simulated in the CMS detector: a collision in which a black micro hole can be created gravitational collapse is not the only process that could create black holes. In principle, black holes could be formed in high energy collisions that achieve sufficient density. Starting from 2002, these events were not detected, nor directly or indirectly as the lack of mass equilibrium in particle accelerator experiments. [135] This suggests that there must be a lower limit for the mass of black holes. Theoretically, this limit is expected to lie around Mass Planck, where the quantum effects are provided to invalidate the forecasts of general relativity. [136] This would make the creation of black holes firmly out of reach of any high energy process that occurs up or near the earth. However, some developments in quantum gravity suggest that the minimum black hole mass could be much lower: some developments in quantum gravity suggest that the minimum black hole mass could be much lower: some braneworld scenarios for example put the border low as 1 TEV / C2. This would make it conceive for black micro holes to be created in high-energy collisions that occur when cosmic rays affect the atmosphere of the earth, or perhaps in the large Hadron Collider at CERN. These theories are very speculative, and the creation of black holes in these processes is considered unlikely by many specialists. [138] Although micro black holes could be formed, it is expected that they evaporated in about 10Â's 25 seconds, doing no threat to the earth. [139] Growth Once a black hole continuously absorbs gas and interstellar powder from its surroundings. This growth process is a possible way through which some supermassive black holes may have been formed, even if the formation of supermassive black holes is still an open search field. [131] A similar process has been suggested for the formation of intermediate black holes. It is thought that it was important, especially in early growth of supermassive black holes, which could have been formed by the aggregation of many smaller objects. [131] The process was also proposed as the origin of some intermediate black, but emit small quantities of thermal radiation at a temperature A§C3 / (8i € GMKB); [64] This effect has become known As hawking radiation. Applying the theory of quantum field to a background of the static black hole, he determined that a black hole should emit particles showing a perfect spectrum of the black body. From the publication of Hawking, many others have verified the result through various approaches. [143] If the hawking theory of black hole radiation is correct, then black holes should be reduced Evaporate over time while losing the mass for the issue of photons and other particles. [64] The temperature of this thermal spectrum (tow temperature) is proportional to the superficial gravity of the black hole, which, for a black Schwarzschild hole, is inversely proportional to the mass. Then, big black black Endless radiation of small black holes. [144] A stellar black holes. [144] A stellar black hole of 1 mâ~ 1 mass. Then big black stellar mass or black holes receive more mass from the background of the cosmic microwave that emit through hawking temperature than 2.7 k (and be able to evaporate,) a black hole would need a mass lower than the moon. Such a black hole would have a smaller diameter to a tenth of a millimeter. [147] If a black hole is very small, radiation effects are expected to become very strong. A black hole with the mass of a car would briefly a brightness of over 200 times that of the sun. The lower mass holes are expected To evaporate even more quickly; For example, a black hole 1 TEV / C2 would require less than 10Å'88 seconds to completely evaporate. For such a small black hole stable, even if current developments in quantum gravity do not indicate this is the case. [148] [149] Hawking radiation for an astrophysical black hole is predicted to be very weak and it would therefore be extremely difficult to detect from the earth. A possible exception, however, is the outbreak of the gamma rays issued in the last phase of the evaporation of the primordial black holes. Research for these flashes have shown failures and provide strict limits on the possibility of existence of low primordial bulk black holes. [150] The NASA Gamma-Ray Space Telescope launched in 2008 will continue searching for these flashes. [151] If the black holes evaporate through hawking radiation, a solar mass hole evaporates (starting from once the background temperature) of the cosmic microwave drops below the black hole) for a period of 1064 years. [152] A supermassive black hole with a mass of 1011 mâ ~ ‰ evaporates in about 2 to 10100 years. [153] Some black holes monsters in the universe are predictable to continue to grow up to 1014 mâ € ‰ during the collapse of superclusters of galaxies. Even these evaporate on a time scale up to 10106 years. 152] Obsive tests Messier 87 Galaxy â € "Home of the first black hole so not emit any electromagnetic radiation other than hypothetical hawking radiation, so astrophysics in search of black hole so not emit any electromagnetic radiation other than hypothetical hawking radiation. Indirect. For example, the existence of a black hole can sometimes be defered by observing its gravitational influence on its environment. [154] On 10 April 2019 an image was released by a black hole, which seen in an enlarged way because the light paths near the horizon of the events are very bent. The dark shadow in the middle results from the light paths absorbed by the black hole. [22] The image is in false color, as the light halo detected in this image is not in the visible spectrum, but radio waves. The impression of this artist depicts photons in the visible spectrum, but radio waves. by the Event Horizon telescope. Event Horizon Telescope (ETH) is an active program that directly observes the immediate environment of the Milky Way. In April 2017, EHT started the observation of the black hole in the center of Messier 87. [155] "In all, eight radio observers on six mountains and four continents have The galaxy in Virgo up and out for 10 days in April 2017 "to provide data that produce the image of a black hole, in particular the supermassant black hole that resides in the center of the abovementioned galaxy. [157] [158] what is visible is not the black hole, which shows black because of the loss of all the light within this dark region, rather than the gases on the edge of the event horizon, which are displayed as oranges or reds, which define the black hole. [159] the growing of this material in the middle of the bottom of the processed eut image is thought to be caused by doppler beaming, so the material that approaches the viewer at relativistic speed is perceived as brighter than the wisible material is rotating at relativistic speeds (> 1.000 m km / s,) the only speeds in which it is possible to balance centrifuge the immense gravitational attraction of the singularity and therefore remain in orbit above the
horizon of the event. this brilliant material configuration implies that the edge, since the entire system rotated clockwise. [160] [161], however, the extreme gravitational tension associated with black holes produces the illusion of a perspective that sees the disk of increase from above. In fact, most of the ring in the image eht was created when the light emitted from the opposite side of the gravity of the sees the disk of increase from above. In fact, most of the ring in the image eht was created when the light emitted from the opposite side of the gravity of the sees the disk of increase from above. prospects on m87 \* can see the whole disk, even the one directly behind the shadow. Before this, in 2015, the eut detected magnetic fields just outside the horizon of their properties. the field lines passing through the growth disk were found a complex mixture of sorted and tangled. the existence of magnetic fields had been foreseen by theoretical studies of black holes. [162] [163] the expected appearance of non-roidal black hole with toroidal ring of ionized matter, as proposed [164] as a model for sagittarius to \*. asymmetry is due to the doppler effect resulting from the huge orbital velocity necessary for the centrifugal balance of the strong gravitational attraction of the hole. detection of gravitational waves of fusion of black holes on September 14, 2015 the observation of gravitational waves success. [11] [165] the signal waves success. two black holes: one with about 36 solar masses and the other about 29 solar masses. [11] [166] This observation provides the most concrete evidence for the existence of black holes until today. For example, the gravitational wave signal suggests that the separation of the two objects before the merger was only 350 km (or about four times the radius of schwarzschild corresponding to the deducted masses.) objects must therefore have been extremely compact, leaving the black holes as the most plausible interpretation. [11] even more important, the signal observed by ligo also included the beginning of the post-fusion rebate, the signal produced as a new format compact object settles in a stationary state. probably, the rounding is the most direct way to observe a black hole. [167] from the lygo signal it is possible to extract the frequency and damping time of the rendation. from these it is possible to deduce the momentum of mass and angular of the final object, which corresponds to the independent forecasts from numerical simulations of the fusion. [168] the frequency and decay of the dominant mode is determined by the geometry of the photonic sphere. [167] Observation also provides the firstTry for the existence of binaries of the stellar black hole. Furthermore, it is the first observational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes that weigh 25 solar masses or more. [169] Since then many other gravitational test of stellar black holes test near the center of our Milky Way provide a strong observational test that these stars are orbiting a supermassive black hole. [170] Since 1995, astronomers have traced the 90-star movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that orbit around an invisible object coinciding with the Sagittarius radio source A. \* collect their movements that are around around are around an invisible object coinciding to deduce, in 1998, that a 2.6Å-106 the object Mâ  $\in$  ‰ must be contained in a volume with a radius of 0.02 light years to cause the movements of those stars. [171] Since then, one of the stars, called S2, completed a complete orbit. From orbital data, astronomers were able to refine mass calculations at 4.3-106 mâ  $\in$  ‰ and a radius of less than 0.002 light years for the object that causes the orbital movement of those stars. [170] The upper limit on the size of the object is still too big to test if it is smaller than its schwarzschild radius; However, these observations strongly suggest that the central object is a supermissive black event the impressions of the artists such as the accompanying representation of a black hole with the crown commonly depict the black hole as if it were a flat-space body that hid the part Of the disc just behind it, but in reality gravitational lenses would greatly distort the image of the accretion disk. [175] NASA simulated the view from the outside of a black Schwarzschild hole illuminated by a thin accretion disk. Within such a disc, friction would cause the transport of angular momentum to the outside, allowing the fall of the most distant material towards the interior, freeing potential energy and increasing the gas temperature. [176] X-ray blur near the black hole (Nustar; 12 August 2014) [173] When the stegrating object is a star of neutron or a black hole, the gas in the orbit of the internal accretion disk at very high speeds due of its proximity to the compact object. The resulting friction is so significant that heats the internal disc at temperatures to which it emits vast quantities of electromagnetic radiation (mainly X-ray). These X-ray light sources can be detected by telescopes. This growth process is one of the most efficient processes of known energy production; Up to 40% of the rest mass of the accumulated material can be emitted along the poles which lead great part of the 'power. The mechanism for creating these jets is not currently well understood, partly due to insufficient data. [177] As such, many of the most energy phenomena of the universe were attributed to the growth of matter on black holes. In particular, the active galactic nuclei and quasars are considered the disks of the supermassive black holes. [178] Similarly, X-ray binaries are generally accepted as binary star systems in which one of the two stars is a compact object that increases matter from its companion. [178] It has also been suggested that some ultrauluminary X-ray sources can be the accretion disks of intermediate black holes. [179] In November 2011 the direct observation of a quasar increase disc around a super-max black hole. It he blue point indicates the position of the black hole. The black hole. The black hole indicates the position of the black hole. The black hole indicates the position of the black hole. The black hole indicates the position of the black hole. The black hole indicates the position of the black hole. The black hole indicates the position of the black hole. The black hole indicates the position of the black hole. The black hole indicates the position of the black hole. The black hole indicates the position of the black hole. The black hole indicates the position of the black hole. The
black hole indicates the position of the black hole indicates the position of the black hole. The black hole indicates the position of the black hole indicates the position of the black hole. The black hole indicates the position of the black hole indicates the black hole indicates the position of the black hole indicates the position of the black hole indicates the black hole indicates the position of the black hole indicates the ingest the gas from the stars of the companions. an image of the X-Ray observatory of cygnus chandra X-1, which was the first strong black hole candidate who discovered that x-ray tracks are binary star systems that emit most of their radiation in the x-ray part of the spectrum. These x-ray emissions are generally designed to determine when one of the stars (compact object) grows from another star (regular.) the presence of an ordinary star in such a system offers the opportunity to study the central object and determine if it could be a black hole. [178] If such a system emits signals that can be directly traced to the compact object, it cannot be a black hole. However, the absence of such signal does not exclude the possibility that the compact object is a neutron star. by studying the compact object. if this is much larger than the Tolman-Oppenheimer-Volkoff limit (the maximum mass that a star can have without collapsing) then the object cannot be a neutron star and is generally expected to be a black hole, [178] the first strong candidate for a black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidate for a black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolton, [182] loise webdin Currently, the best candidates for black hole, cygnus X-1, was discovered in this way by charles thomas Bolt system class, the star of the companion is relatively low mass that allows for more accurate estimate of the mass of the black hole. Moreover, these systems actively emit x-rays for only several months once every 10-50 years. during the detailed observation of the star appears during this periodic oscillations and are thought to be caused by material oscillations almost periodic oscillations and are thought to be caused by material moving along the inner edge of the disk of increase (the more internally stable circular orbit.) as such their frequency is linked to the mass of black holes candidates.[186] see also: active galactic nucleus magnetic waves, called alfvén S-waves, flow from the base of black hole jets. Astronomers use the term "active galaxies" to describe galaxies with unusual features, such as unusual spectral emission and very strong radio emission. Theoretical and observative studies have shown that activity in these active galaxies with unusual features, such as unusual spectral emission and very strong radio emission. millions more massive than stellar ones. the models of these agn are constituted by a central black hole that can be millions or billion times more massive than the sun; an interstellar gas disc and powder called an accretion disk; and two perpendicular jets to the accretion disk; and two perpendicular jets to the accretion disk. [187][188]A\*, a black hole in the center of the Milky Way even if you expect in most AGNs you are supermassive black holes, only a few galaxies cores have been studied more carefully in attempts to identify and measure the actual effective of the candidates include Andromeda Galaxy, M32, M87 NGC 3115, NGC 3377, NGC 4258, NGC 4889, APM 08279 + 5255 and the Sombrero galaxy, not only active, contains a supermassive black hole. [191] The close observative correlation between the mass of this hole and the dispersion of the speed of the bulging of the Galaxy host, known as the mât "Sigma Relation, strongly suggests a connection between the formation of the black hole in the middle of the black hole in the middle of the black hole in the middle of the black hole and that of the black hole in the black hole in the middle of the black hole in the black of an object can be tested in the future is by observing the effects caused by a strong gravitational field nearby. One of these effects is the gravitational field nearby. One of these effects is the gravitational field nearby as much as the light passing through an optical lens. in which light rays are deviated from only a few arcseconds. However, it has never been observed directly for a black hole. [194] A possibility for the observe the stars in orbit around the black hole. There are several candidates for such observation in orbit around the Sagittarius A. [194] Alternative See also: exotic stars The tests for stellar black holes strongly rely on the existence of a higher limit for the mass of a neutron star. The size of this limit depends strongly on the assumptions made on the properties of the dense question. The new exotic phases of matter could push on this limit. [178] A high density free quark phase could allow the existence of dense Quark stars, [195] and some supersymmetrical models predict the existence of Q stars. [196] Some extensions of the standard model place the existence of Q stars. [197] These hypothetical models could potentially explain a series of observations of black hole stellar candidates. However, it may be shown by arguments in the general relativity that any such object will have a maximum mass. [178] Since the average density of a black hole stellar candidates. star black holes (the average density of a black hole is much better understood and the possible alternative explanations for the observations of the supermassive black hole are much more trivial. For example, a supermassive black hole could be shaped by a large cluster of very dark objects. However, such alternatives are generally not stable enough to explain the candidates of supermassive black holes implies that so that black holes do not form, general relativity must fail as a theory of gravity, perhaps due to the beginning of guantum mechanical corrections. A very early feature of a theory of guantum gravity is that it will not be true artifacts. [198] For example, in the Fuzzball model based on string theory, the individual states of a black hole solution do not generally have a horizon of events or singularities, but for aclassical, the statistical average of such states appears just as an ordinary black Forum as deduced by general relativity. [199] Some theoretical objects have been conjectured to match observations of astronomical candidates of the black hole identically or almost identically, but what function through A A A Amechanism. These include the gravastar, the black hole area (A). The constants are the speed of light (c), the Boltzmann constant (k), the Newton constant (b). In Planck units, this reduces to S = A/4. In 1971, Hawking showed in general conditions[Note 5] that the total area of event horizons of any collection of classic black holes can never decrease, even if they collide and join.[202] This result, now known as the second law of black hole mechanics, is remarkably similar to the second law of thermodynamics, which states that the total entropy of an isolated system can never decrease. As with the classic zero temperature objects, it is assumed that black holes have zero entropy. If this were the case, the second law of thermodynamics would be violated by the entropy-laden matter entering a black hole, resulting in a decrease in the total entropy of the universe. Bekenstein proposed that a black hole should have been proportional to its horizon area. [203] The link with the laws of thermodynamics was further strengthened by Hawking's discovery in 1974 that quantum field theory predicts that a black hole radiation will take away the energy from the black hole that causes it to shrink. The radiation, however, also takes away entropy, and can be demonstrated under general assumptions that the sum of the entropy of the matter surrounding a black hole and a quarter of the horizon area as measured in Planck units is in fact always increasing. This allows the formulation of the first law of the matter surrounding a black hole and a quarter of the horizon area as measured in Planck units is in fact always increasing. energy, the surface gravity as temperature and the area as entropy. [203] An amazing feature is that the entropy of a black hole scale with
its area rather than its volume, since entropy is normally a large amount that linearly scales with the volume of the system. This strange property has led Gerard 't Hooft and Leonard Susskind to propose the holographic principle, which suggests that anything that happens in a volume of spacetime can be described by the data on the border of that volume.[204] Although general relativity can be used to perform a semi-classical calculation of black hole entropy, this situation is theoretically unsatisfactory. In statistical mechanics, entropy is meant to count the number of microscopic configurations of a system that has the same macroscopic qualities (such as mass, charge, pressure, etc.). Without a satisfactory theory of quantum gravity, such a calculation cannot be performed for black holes. Some progress has been made in various approaches to quantum gravity. In 1995, Andrew Strominger and Cumrun Vafa showed that the microstad count of a specific supersymmetric black hole in string theory played the Bekenstein-Hawking entropy. [205] Since then, similar results have been reported for several black holes in both string theory played the Bekenstein-Hawking entropy. [205] Since then, similar results have been reported for several black holes in both string theory and other guantum gravity approaches such as the guantum gravity appro information loss paradox: Information paradox on the black hole is lost. Regardless of the type of matter that went to form the black hole is lost. Regardless of the type of matter that enters a black hole, it seems that only information about the total mass, the charge and the angular moment is kept. As long as the black holes were to persist for ever this loss of information is not that problematic, since information of events in accordance with the holographic principle. However, black holes evaporate slowly emitting hawking radiation does not seem to carry any further information is really lost in black holes (the information paradox on the black hole) has divided the theoretical community of physics (see thorneâ eroperty called unitary, and claimed that the loss of unit would also imply violation of energy conservation, [208] even though this was disputed. [209] in recent years the test has been built that in fact information and unity are preserved in a complete gravitational treatment of the problem. [210] an attempt to solve information and unity are preserved in a complete gravitational treatment of the problem. demonstrating that the complementarity of the black hole cannot solve the information paradox. According to the theory of quantum field in curved spacetime, a single emission of hawking radiation; the infallible particle is swallowed by the black hole. Take a black hole formed a finished in the past and will completely escape at some time finished in the future. therefore, it will issue only a limited amount of information encoded within its hawking radiation. particle in ocita must be entangled with all hawking radiation that the black hole has previously been issued. This apparently creates a paradox: a principle called entanglement's "monogamy" requires that, like any quantum system, the ocyte particle cannot be fully entangled with two other systems at the same time; and yet here the ocita particle appears to be entangled with both the infalled and independently particle, with the radiation of past hawking. [213] to resolve this contradiction, the physicists may possibly be forced to renounce one of the three temporary principles on time: the principle of einstein equivalence, the unity or theory of the local quantum field. a possible solution, which violates the principle of equivalence, is that a firewall destroys the particles entering the horizon of the event [214.] in general, that - if someone "of these assumptions should be abandoned remains a topic of debate. [209] see also binary black hole in fiction blanet btz black â â â â â â â â â â â â a â [82] The (ester) event horizon radius scales as: m + m 2 â'(j / m) 2 â' q 2. {\displaystyle m + {\ sqrt {m} {2} - {j / m} {2} the global lines of light ray), it is Inclined this way in Eddingtonà ¢ â, ¬ "Finkelstein Coordinates (the diagram is a" cartoon "version of a coordinates (the diagram is a" cartoon "version of a coordinates (the diagram is a" cartoon "version of a coordinates (the diagram is a" cartoon "version of a coordinate diagram is a" cartoon "version of a coordinates (the diagram is a" the event, and in Kruskal-Szekeres coordinated light cones do not change shape or orientation at all. This is true only for four-dimensional space times. In the higher dimensional space times. In the higher dimensional space times of the horizon are possible as a black ring [97] [98 ^ in particular, has assumed that all matter meets the weak energy condition. 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