Article

Black Hole and Time: What Science Says About

Claudio Emiah, PhD; Michael H. Fisher, PhD

SUMMARY

Most thoughts about the beginning of the Universe say that it happened about 15 billion years ago. An explosion known as the Big Bang was at its origin and due to this all the matter in the Universe, including space and even time, itself, were all together released during this event. Afterwards, it is said that hundreds of millions of years followed before matter could start collecting into clouds so vast that under their own weight, they would coalesce and collapse, into the first stars. The first stars being too hot, huge and powerful they unfortunately were enormous consumers in terms of material quantities. They could therefore only shine for a few hundred million years before dying. Today our Sun is said to have been shining for over four and a half billion years in comparison to the first stars. With the death of the first powerful stars an explosion that followed propelled off material that became incorporated into the next generation of suns. However due to their enormous masses, their cores continued to shrink until they formed gigantic black holes which were billion times more massive than our Sun. Over the past decade researchers realized that at least one black hole is present in the center of most galaxies. Scientists having previously measured the light coming from distant exploding stars tried to demonstrate that the universe is expanding at an accelerating rate. They used the assumptions that as the universe ages these supernovae are also spreading out fast. They also assumed that driving the galaxies apart, are a kind of anti-gravitational force and they named this unidentified force “dark energy”. Ideologies that time itself could cease to be in billions of years still exist till present day arguing that when it happens everything will come to a halt, an alternative explanation for “dark energy”, the mysterious anti-gravitational force that has been suggested by scientists since no one has yet found any evidence or proof of dark energy.■

KEYWORDS Black hole; Time; Universe; Future; Life; Materials

Sci Insigt. 2016; 2016:e00247. doi:10.15354/si.16.ar365

Author Affiliations: Author affiliations are listed at the end of this article.

Correspondence to: Michael H. Fisher, PhD, Division of Physics, The BASE, Chapel Hill, NC 27510, USA
Email: mhfisher@basehq.org

DEFINITION OF BLACK HOLE

We define a black hole as a region in space time with such a strong gravitational force that nothing can escape from it. This includes particles and even electromagnetic radiations such as light. Albert Einstein's Predictions from his theory of general relativity support the fact that a sufficient compact mass would deform the space time creating a black hole. This directly implied that gravity directly influences the motion of light.

A black hole is black in all the senses of the word. This implies that no light can escape from a black hole. Equally it is impossible to sense a black hole even when using our recent equipments. These include light rays, x-rays or the likes. According to NASA, the only sign which can show the existence of a black hole is only found looking at the usual of a black hole effects on the surrounding environment. A black hole can naturally pull up a star and tear it apart. When this happens, the matter from the star is gradually absorbed towards the black hole the latter eventually growing hotter, bigger and glows brightly in x-rays.

In a black hole, the region's boundary from which no escape is possible is called the event horizon. Object crossing the event horizon might undergo very big changes even though it will present no locally detectable features. A black hole behaves in the same way an ideal black body will do since no light will be reflected through it. According to the quantum field theory in curved space time, it is explained that an event horizon will emit Hawking radiation, with the same spectrum or field pattern as a black body of a temperature inversely proportional to its mass.

DEFINITION OF TIME

Time on the other hand refers to the continued and indefinite progression or evolution of existence and events which happen in irreversible successions having commenced in the past and continues till present towards the future. Some sources even define time as the fourth dimension. Quite often time is referred to as a component quantity of measurements which is of use on the sequencing of events, comparing the duration of a particular event or the duration between consecutive events. Time might also be used to quantify or determine rates of change of quantities.

The way philosophy defines time exists practically in two contrasting viewpoints. These viewpoints brought about a division in the world of philosophy and their prominent philosophers. One views time as part of the fundamental structure of the universe. That is an event independent dimension, where in events occur sequentially. Sir Isaac Newton adhered to this realist view and supported it's meaning, and hence sometimes this viewpoint is referred to as Newtonian time. Opposing this view, the second proposal views time in the sense of neither referring to any kind of container in which events and objects will are moving in, nor to any entity that is to flow. Rather it says that time is instead part of a fundamental intellectual structure combined with space and number all together forming a structure within which humans sequence and compare events. This second view was supported by Gottfried Leibniz and Immanuel Kant explaining that time is neither an event nor a thing, and thus is not measurable or even be travelled.

HISTORY OF BLACK HOLES

Objects with such strong gravitational fields incapacitating even light to escape were first considered by John Michell and Pierre-Simon Laplace in the 18th century. In 1783, John Michell wrote his publications in a letter to Henry Cavendish of the Royal Society.

It was not long that Pierre Simon Laplace with his book called Exposition du systeme du monde and its two editions corroborated this theory. However, such theories were not taken seriously even in the nineteenth century. This was because scientist could not understand how light, such a massless wave could be influenced by gravity.

It was in 1916 however that the first modern solution of general relativity characterizing a black hole was found. Its founder was a man by the name Karl Schwarzschild. In 1958 David Finkelstein published out a document on black hole bringing in its definition as a region of space from which nothing can escape. Black holes have for long been taken as a mathematical curiosity. During the 1960s some mathematician's theoretical work showed they were a generic prediction of general relativity. A discovery of neutron stars which sparked interest in gravitationally collapsed compact objects as being a possible astrophysical reality.

When very massive bodies of stars collapse at the end of their life cycle it brings about the formation of

Black holes of stellar masses. After its formation, it either will continue growing by absorbing mass from its immediate surrounding environment or it will conserve its size but it can never decrease or reduce. However supermassive black holes of millions of solar masses may be formed by absorbing other stars or by merging with other black holes. Generally there are predictions concerning the existence of supermassive black holes present in the centers of most galaxies.

Presenting the interior of a black hole as invisible, we can however infer to it through the way it interacts with other matter and electromagnetic radiation such as visible light, x-rays etc. Matter that's falls into a black hole ends up forming an external accretion disk heated by friction and leading to the formation of some of the brightest objects existing in the universe. If other stars orbit a black hole, determination of the black hole's mass and location is possible through the stars' orbits. Such observations exclude other possible alternatives ways like the neutron stars. Astronomers have in similar ways identified numerous possible stellar black holes in our binary systems, and came to the conclusion a supermassive black hole of about 4.3 million solar masses is found near Sagittarius A* a well-known radio source situated at the core of our own Milky Way galaxy.

The LIGO collaboration on 11th February 2016, announced the first gravitational waves observation. These waves were generated by a black hole merger and it was the first direct detection of a binary black hole merger. Although a huge supermassive black hole lurks in the middle of our galaxy. Luckily, our planet Earth is about two-thirds distance away out from the center of the Black Hole as compared to the rest of our galaxy. However we can certainly observe its effects from afar. The European Space Agency says that our Black Hole mass is four million times more than that of our Sun, and that surprisingly hot gas surrounds it.

HISTORY OF TIME

Some ancient cultures believe in a concept of a wheel of time. This means that they regard time as being cyclical and quantic basically consisting of repeating ages that occur to every being in the Universe between their birth and extinction. These cultures include the Incan, Mayan, Hopi, and other Native American Tribes - plus the Babylonians, Ancient Greeks, Hinduism, Buddhism, Jainism, and some others.

Time is seen as linear and directional, according to the Islamic and Judeo-Christian world-view. This mostly starts with the act of creation by God. Christian view still traditional as in the past sees time ending, with the well-known end of the present order of things, the "end time".

The Book of Ecclesiastes, written by the King Solomon makes us understand that time was traditionally regarded as a way for the passage or occurrence of predestined events.

In the Greek language two distinct principles namely the Chronos and Kairos are denoted. Chronos refers to the numeric, or the chronological, time while the latter, Kairos literally described as the opportune or the right moment", particularly referring to the Divine time. In theology, Kairos is take more of qualitatively than quantitatively.

Greek mythology identifies the Chronos to be the Personification of Time. Chronos is mostly a portrait of an old, wise man having a long, gray beard, to relate to a "Father Time." His name in Greek signifies "time" and is spelled Chronus in Latin or Khronos as other alternatives.

Kabbalists say that "time" is a paradox and an illusion. They foresee both future and past as being combined and present simultaneously. Gottfried Leibniz and Immanuel Kant, explain that space and time do not coexist in and out of themselves. Instead they are the outcome of the way in which we represent things. This is explained by the fact that we only know objects only as they appear to us.

The earliest texts in Indian and Hindu philosophy are called the Vedas. These texts can be traced back to the late 2nd millennium BC and they describe ancient Hindu cosmology. Here, the universe is described as going through repeated and repeating cycles of creation, destruction and rebirth. Also, it is said that each cycle lasts for 4,320 million years. Some ancient Greek philosophers like Parmenides and Heraclitus, wrote during their time certain essays on the nature of time. Plato referred to time with the numerous period of motion of the heavenly bodies in his book called the Timaeus. Identifying time as being with respect to the before and after, the number of movement was an Aristotle publication.

St. Augustine of Hippo in his Book 11 of his Confessions kept on asking himself questions about the nature of time. St. Augustine in his definition of time starts by what it is not rather than what it is. This was an ap-

proach similar to the ones in other negative definitions. However, he nevertheless ends by calling time as a "distention" of the mind by which we grasp the past using our memory, the present with our attention, and the future by expectation or hope and all this simultaneously.

Ancient Greek philosophers believed that the universe was made up of an infinite past and no beginning and have always been in contradictions with medieval philosophers and theologians who instead developed the concept of the universe as having a finite past and including a beginning. The latter view is also being shared by Abrahamic faiths as they say and believe that time started by creation. This thereby makes God in their beliefs the only thing being infinite and excludes everything else and even time which is finite.

The notion of absolute space and absolute time was the belief of Isaac Newton. Leibniz instead in his own belief, time and space were relational. The contrast between Leibniz's and Newton's interpretations of time came ahead in the well-known Leibniz–Clarke correspondence.

Immanuel Kant, wrote two books. One which was called the Critique of Pure Reason and the other book he called a Priori Intuition, Space. He depicted time to be a priori intuition that could allow one to understand sense experience. According to Kant, neither space nor time are identified as substances. Rather, both are the elements of a systematic mental framework which necessarily has to structure any rational agent or observing subject's experience. He said time was never an empirical concept, arguing that neither its co-existence nor its succession could be perceived by us humans. For this to be possible time had to exist as a foundation (a Prior). In time measurements, spatial measurements are used to quantify or measure the extent of and distances between objects while temporal measurements are used to measure the durations of events or between them. Time as a Kant's design was the purest possible diagram of a pure category or concept.

Another belief was one of Henri Bergson. He thought of time as neither being a real homogeneous medium nor a mental construct. He explained his view of time as one possessing what he referred to as Duration. Bergson's view of duration was one which had creativity and memory as being an essential component of reality.

Martin Heidegger believed that we do not exist inside time but that we are time. This brought a relationship between the past and present as an awareness of having been and therefore allowing the past to exist in the present. Also the relationship to the future was seen as being the state of anticipating a potential possibility, task, or engagement. It related to the human character of caring and being concerned, which led to a situation he described as being ahead of oneself when one is thinking of a pending occurrence. Therefore, this concept of a potential occurrence would also allow the future to exist in the present.

The present therefore would become a non-quantitative but a qualitative experience. Heidegger seemed to think this as a way in order that a linear relationship with time, or temporal existence, could be easily broken down or transcended. In sequential time, one does not find himself stuck. They would be able to remember the past hence project into the future. Implying that one could randomly have or obtain access to their representation of temporal existence. This also suggested that we could, in our thoughts, step out of sequential time or ectasis.

In 5th century BC Greece, the Sophist named as Antiphon preserved in a fragment out of his chief work which was called On Truth. Time in accordance with this book was not a reality or hypostasis. Time could however be a concept (noêma) or a measure (metron)." Parmenides went even further, maintaining that time, motion, and change were all illusions, leading to the paradoxes of Zeno who was one of his followers. In Buddhist thought there also exist a saying which says time is an illusion.

J. M. E. McTaggart's 1908 in his edition of the Unreality of Time argues that, since every event possesses the characteristic of being both present and not present meaning at the same time belonging to the future or past, it then implies that time is a self-contradictory idea. This was also found in the flow of time.

These arguments are often centered on the meaning of something being unreal. However modern day's physicists generally believe time as being as real as space. Other physicist like Julian Barbour argues in his book The End of Time that the quantum equations of the universe take their true form only when they are being expressed in the timeless realm. This is augmented by the fact that in a timeless real, every possible now or momentary configuration of the universe is contained and known in other words as Platonia by Barbour.

THE BLACK HOLE, TIME AND THE BIG BANG THEORY

Gravitational collapse needs a great density as a necessity to be satisfied. These high densities are only found in stars in this current age of the universe. This was rather not the case in the early universe shortly after the big bang in where densities were much greater, a situation that possibly allowed for the creation of black holes. The formation of black holes is however not triggered by high densities alone since a uniform mass distribution will not allow the mass to bunch up. The presence of initial density perturbations is a must condition to the formation primordial black holes in such dense mediums and to their eventual growth. There exist many different models for the early universe. These models vary widely in their predictions of the size of these perturbations. Some of the models predict the creation of black holes which range from a Planck mass up to hundreds of thousands of solar masses. The creation of any type of black hole could thus be accounted for due to the existence of Primordial black holes.

Stephen Hawking was the first in particular to address a relationship between time and the Big Bang. He wrote his ideologies in a book called A Brief History of Time and elsewhere. He is persuaded that even if time did not begin with the Big Bang and that another time frame before the Big Bang still existed, we would unfortunately have no accessible information from the events that occurred. Moreover his argument on the present time-frame is that it would never be influenced by something which happened then. Hawking has even occasionally stated that time actually began with the Big Bang which was not illogical for him to continue by saying that it would be meaningless trying to know what happened before the Big Bang. This is a type of less-nuanced formulation which is however a commonly repeated one. Furthermore various criticisms from philosophers such as Mortimer J. Adler an Aristotelian have been substantially against this Hawking thought.

Scientists have however come to some basic agreement on descriptions of events that happened 10–35 seconds after the Big Bang. They also agreed conventionally that descriptions of what happened just after the Big Bang and before one Planck time which is numerically calculated as $5 \times 10–44$ seconds are likely to remain pure speculation.

The Big Bang model being a well-established model in cosmology might likely be refined in the future. The earliest moments of the universe's history are still a mystery to scientists. Theorems like the Penrose Hawking singularity theorems need the existence of a singularity at the beginning of cosmic time in order to be substantial. These theorems also assume that general relativity is correct, they however continued by saying that before the universe should reach, Planck's temperature general relativity must be broken down which is the only condition for which a correct treatment of quantum gravity might be found avoiding the singularity.

In principle it is likely that there exist parts of the universe so distant that they cannot be observed under the condition that inflation has indeed occurred. This can be sustained by the fact that exponential expansions would lead to pushes in large regions of space and beyond a horizon we can observe. Some proposals to each of the untested hypotheses are as follows:

- In models like the Hartle–Hawking boundary condition where the whole of space-time is finite; the Big Bang does represent the limit of time without a singularity principle necessity.
- With Brane cosmology models, inflation is due to the movement of branes in string theory. For the pre-big bang model and the ekpyrotic model where in the Big Bang is the result of a collision between branes and for the cyclic model which is a variant of the ekpyrotic model a condition to be satisfied should be one of collisions to occur periodically.
- Inflation events which start in random quantum-gravity foam and lead to a bubble universe expanding from its own big bang are called Chaotic inflation.

Proposals in the last two categories also often the Big Bang as an event containing a much larger and older universe or multiverse excluding therefore a beginning out of nothing.■

ARTICLE INFORMATION

Author Affiliations: Division of Physics, The BASE, Chapel Hill, NC 27510, USA (Emiah, Fisher).

Author Contributions: Dr. Fisher had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Both authors.
Acquisition, analysis, or interpretation of data: Both authors.
Drafting of the manuscript: Emiah.
Critical revision of the manuscript for important intellectual content: Both authors.
Statistical analysis: N/A.
Obtained funding: N/A.
Administrative, technical, or material support: Fisher.
Study supervision: Fisher.

Conflict of Interest Disclosures: All authors declared no competing interests of this manuscript submitted for publication.

Funding/Support: N/A

Role of the Funder/Sponsor: N/A

How to Cite This Paper: Emiah C, Fisher MH. Black hole and time: What science says about. Sci Insigt. 2016; 2016:e00247.

Digital Object Identifier (DOI): http://dx.doi.org/10.15354/si.16.ar365.

Article Submission Information: Received, April 22, 2016; Revised: June 10, 2016; Accepted: June 12, 2016.

REFERENCES

1. http://www.cosmotography.com/images/supermassive_blackholes_drive_galaxy_evolution_2.html
2. http://www.dailygalaxy.com/my_weblog/2014/11/-time-is-slowly-disappearing-from-our-universe-or-is-it-timeless.html
3. http://www.hawking.org.uk/the-beginning-of-time.html
4. http://www.scientificamerican.com/article/2-futures-can-explain-time-s-mysterious-past/
5. http://www.universetoday.com/114182/what-time-is-it-in-the-universe/
6. https://www.insidescience.org/content/every-black-hole-contains-new-universe/566
7. http://math.ucr.edu/home/baez/physics/Relativity/BlackHoles/universe.html
8. http://www.physicsoftheuniverse.com/topics_blackholes.html
9. https://www.technologyreview.com/s/419827/why-our-universe-must-have-been-born-inside-a-black-hole/
10. https://dash.harvard.edu/bitstream/handle/1/4554328/Denef_Black_Hole_Determ[1].pdf?sequence=2
11. http://www.natureworldnews.com/articles/20609/20160408/behemoth-black-hole-found-unexpected-place.htm
12. http://observer.com/2016/03/columbias-black-hole-expert-on-the-end-of-the-world-as-we-know-it/
13. https://books.google.com/books?id=WVDgdh2hfNcC&pg=PA406&lpg=PA406&dq=the+black+hole+determinant+of+the+world&source=bl&ots=lVsNCxyxzW&sig=AIiYgxU1PFLU21Gicf4LtFsE4XI&hl=en&sa=X&ved=0ahUKEwj6k9H4j6LNAhUCWx4KHS2MB-YQ6AEIQTAF
14. http://mitchell.tamu.edu/archive/AdS-CFT/documents/Hartnoll.pdf
15. https://en.wikipedia.org/wiki/Time
16. http://www.big-bang-theory.com/
17. http://www.space.com/25126-big-bang-theory.html
18. http://science.howstuffworks.com/dictionary/astronomy-terms/before-big-bang.htm
19. http://discovermagazine.com/2013/september/13-starting-point
20. https://en.wikipedia.org/wiki/Big_Bang
21. http://www.skyandtelescope.com/astronomy-resources/time-changed-inside-a-black-hole/
22. http://physics.stackexchange.com/questions/25759/how-exactly-does-time-slow-down-near-a-black-hole
23. http://hubblesite.org/explore_astronomy/black_holes/encyc_mod3_q15.html
24. http://curious.astro.cornell.edu/physics/89-the-universe/black-holes-and-quasars/theoretical-questions/455-what-happens-to-spacetime-inside-a-black-hole-intermediate
25. http://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-black-hole-58.html
26. http://ngm.nationalgeographic.com/2014/03/black-holes/finkel-text
27. http://www.einstein-online.info/spotlights/changing_places ■