



# Professor Stephen Hawking and the Universe

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## Plan

My aim is to gather as much information about Professor Stephen Hawking as possible and show how his work and teachings lay out the path for a better tomorrow for us all.

I will use one of the most famous published books of today “A Brief History of Time”, written by Prof. Stephen Hawking and various web sites ranging from the Wikipedia to his very own site, [Hawking.org.uk](http://Hawking.org.uk).

The data I will use will be pictures, drawings, facts and formula to enable me to present data more easily and allow the reader to understand, since a lot of Stephen Hawking’s work is theory, there is very little statistical, graphical or hard evidence to back up his theories as we do not have the advanced technology needed for such a task.

Below are a few questions that I pondered on before reading a Brief History of Time and I am hoping will be answered by the end of this project :

- Will we always play catch up with science?
- Once we discover something has it already changed?
- Should we try to discover what *was* or what *will* be?
- Is it more dangerous to ignore the past or the future?
- Why is no one content to accept that we exist because we exist?
- How are we here?
- How will it all end and what will happen to make this occur?
- Is time running out for us?

## **Introduction**

For my Science and Technology in Society Assignment I was asked to produce a project based on a Hero of Science and Technology and I have chosen Professor Stephen William Hawking.

One of the reasons I chose him is because when asked to choose two people in the world I would like have a conversation with my answer has always included Prof. Hawking whose theory may not be easy to comprehend but his straight talking and easy to understand description lets you know where his mind is taking you.

Another reason why I have admiration for Stephen Hawking is due to his disability. To be informed that you may not have long to live would be a terrible blow to anyone. Indeed few would be able to carry on with their normal lives never mind put every effort into continuing research in general relativity and cosmology but this man listened to his dreams and remembered others who were suffering at the hands of their illness and carried on regardless. Even though he lives with amyotrophic lateral sclerosis, his capability to overcome such physical limitations is astounding, and even with his illness, has delivered many public lectures by using an electronic voice synthesiser.

I put Prof. Hawking forward because even though he strives to find the single theory that the universe is governed and constantly working in his demanding field of research, he still wants to deepen the knowledge and understanding of space and time to the average person by his books and lectures. I believe it is to help us help ourselves.

# The voice we hear!

Stephen Hawking, CH, CBE, FRS, FRSA is the most well known scientist alive today. He is a well-respected man from whom other scientists ask advice and come to hear his lectures from far and wide. His books are the basis of my project and are admirable. This great mathematician can make you aware of the complex by using basic explanation.

Stephen Hawking was born on 8<sup>th</sup> January 1942 in Oxford, England. A fascinating coincidence is that his birthday is three hundred years to the day that Galileo died. When he was old enough to attend Oxford Stephen wanted to study Mathematics. However this course was unavailable and opted for the closest subject to Mathematics, Physics (not medicine as his father had hoped).



In 1962 Stephen then went on to Cambridge to do research in Cosmology under Denis Sciama. It was at the beginning of the following year that Stephen was diagnosed with ALS (amyotrophic lateral sclerosis). Until this point he had never really cared for any physical sports, except rowing, which contented him, but by his 21<sup>st</sup> birthday he was being poked and prodded by a specialist to diagnose the mystery symptoms.

The diagnosis was that he had an incurable disease that was likely to be terminal within a few years and so the doctors advised Stephen to go back to Cambridge and carry on with the research he had started in general relativity and cosmology. The disease causes muscles to become useless over time and an early death is inevitable. Professor Hawking did not let this disease hinder his progress, which he stated required more thinking than physical demands.

In 1965, Penrose published Hawking's work on applying Roger's singularity theory to the entire universe. Stephen Hawking worked on the basic laws which rule the universe and with Roger Penrose he showed that Einstein's General Theory of Relativity implied space and time would have a beginning with the Big Bang and an end in black holes. This publication is what earned Stephen his Ph.D.

After he had achieved his Ph.D. he soon became a Research Fellow, a Professorial Fellow at Gonville and Caius College and in 1973 he left the Institute of Astronomy and went to the Department of Applied Mathematics and Theoretical Physics. Since 1979 he has held the post of Lucasian Professor of Mathematics. This status and significant position had belonged to Isaac Barrow and Isaac Newton.

Hawking became Commander of the Order of the British Empire in 1982. Unfortunately in 1985 he caught pneumonia, which led to a tracheotomy operation and now he uses a speech synthesizer. Even though he is confined to a wheelchair and can no longer speak this has not stopped this brilliant mind and he has continued to teach and lecture to students and colleagues. Stephen Hawking became a Companion of Honour in 1989 and is a member of the Board of Sponsors of The Bulletin of the Atomic Scientists.

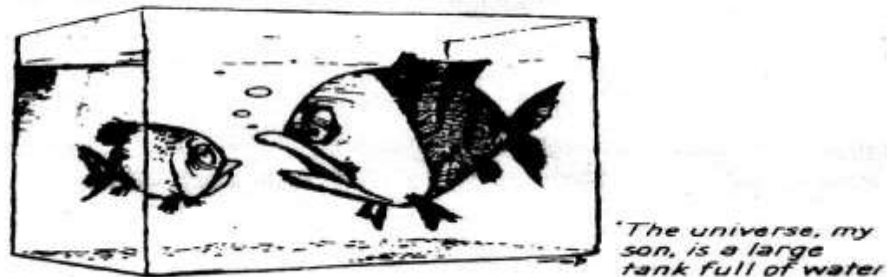


FIG. 1

### What is Cosmology?

Cosmology is a study of the heart of creation. It is the existence of everything, our universe – the origin, evolution and what is yet to come. (As Fig. 1 plays on the fact that it is more than just what you see around you intensified).

All of the questions everyone now asks have theories behind them and the eventual goal of science is to provide a single theory that describes the whole universe.

Theory plays a big part in cosmology. A good theory needs to answer and prove two questions:-

1. Can it accurately describe a large set of observations on a basis of a few argumentative points?
2. Can it make definite predictions about the results of future observations?

To prove a theory you must always break it down and search from the very large (general relativity) to the very small (quantum mechanics). However general relativity and quantum mechanics can contradict when brought together and this is what makes the task so demanding.

Stephen Hawking has a real thirst for knowledge and a brilliant understanding of how the universe operates. Aristotle and the Greeks thought that the human race once existed previously and was destroyed by floods and other disasters and we had to start civilisation all over again, but with Stephen Hawking we have come a long way since then. He has worked on the basic laws of the universe and, with Penrose, has shown the world that by using Einstein's General Theory of Relativity would prove Space and Time would have to a beginning with the Big Bang or Singularity Theory.

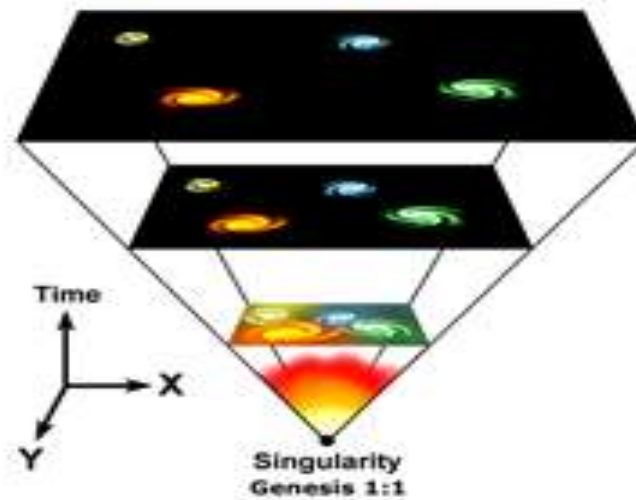


FIG. 2

A singularity marks a point where the curvature of space-time is infinite. If the universe did begin at a point in time – The Big Bang, so then must it come to an end as well – The Big Crunch. Since you cannot have a start of a race without a finish, you also cannot have a finish without a start. However, there are some who choose to view the universe as a continuous creation but this is not supported by the mathematical findings. It can be proven that space is not static but ever expanding and growing all the time, with distant galaxies travelling further away all the time and so if you were to reverse the process then 20 thousand million years ago, we would all be in the same place with a suggestion of an initial explosion to send us in motion.

He also supplied the mathematical proof that a black hole is a natural phenomenon and black holes should not be completely black, but should emit radiation and eventually evaporate and disappear. Black holes are described by the three properties of mass, angular momentum and electric charge. He states that after the Big Bang mini black holes were formed and upon analysis of gamma ray emissions, he calculated that they should thermally create and emit subatomic particles known today as Hawking radiation. This is one of his most famous discoveries.

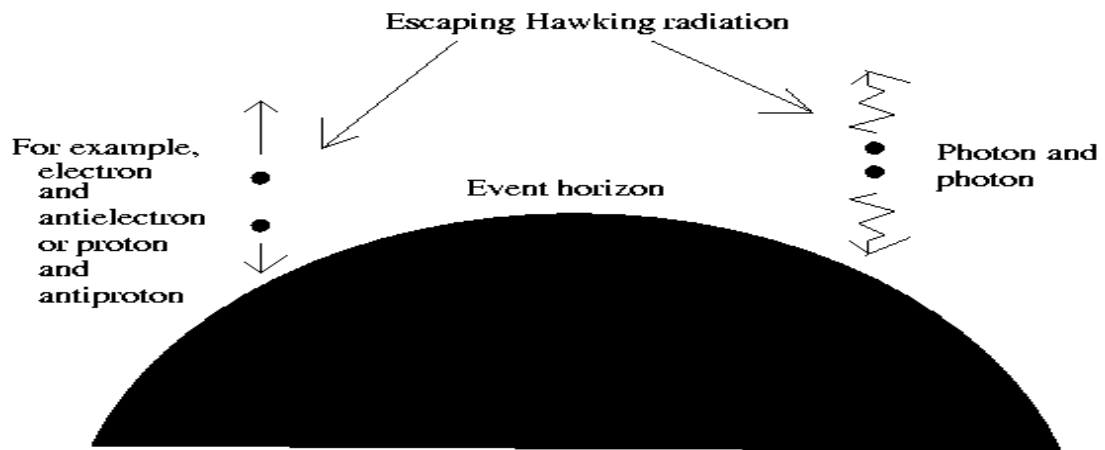


FIG. 3

Fig. 3 shows the different particles escaping a black hole, when this happens the black hole loses a small amount of energy and its mass. Below is some of the mathematical conclusions we can draw from Hawking's findings:-

This is the lifetime of a black hole:

$$t_1 = \frac{M_0^3}{3K}$$

$t_1$ : total time for evaporation

$M_0$ : initial mass

The formula tells us that the lifetime of a black hole is proportional to the cube of its mass. That means a massive black hole takes proportionally much longer time to evaporate, and the process of evaporation quickens as the black hole gradually loses its mass. This is known as the "runaway" effect.

The temperature formula of a black hole:

$$T = \frac{h \cdot c^3}{16\pi^2 \cdot k \cdot G \cdot M} \approx \frac{1.228 \cdot 10^{23}}{M} \text{ K kg}$$

$h$ : the Planck's constant;  
 $M$ : mass of a black hole;

$k$ : the Boltzmann constant;  
 $c$ : the speed of light;

$G$ : the gravitational constant;

We see that as the black hole loses its mass then its temperature will increase. When a black hole gets extremely small, its temperature may become so high that it may burn up and cause an explosion and so could potentially bring us back to the creation of the universe.

Some of Hawking's other scientific investigations are the study of:

quantum cosmology, cosmic inflation, the density matrix of the universe, topology and structure of the universe, baby universes, spacetime foam, string theory, gravitational radiation and wormholes. He is also now trying to convince other physicists that there was no singularity at the beginning of the universe, clearly showing that this man can admit to his mistakes and is not too proud to go back to the start and work hard on something that he may have thought correct to begin with.

One of Stephen Hawking's most famous books "A Brief History of Time" involves an investigation into the beginning of the universe and an understanding of how the universe operates, this book was at the top of the bestseller list for 237 weeks. The sequel to "A Brief History of Time" and winner of the 2002 Aventis Prizes for Science Books was "The Universe in a Nutshell". Another book that helps the public understand the universe we live in is "George's Secret Key to the Universe" by Stephen and Lucy Hawking, this book helps bring a modern vision of cosmology.

# Why bother with Cosmology?

Cosmology is the start of understanding more about what our future holds but not just for the human race but the ecosystem, the sky, the time and space that we use.

There was once a time that man was afraid of the night sky and the empty space above but now we have some knowledge and understanding of it. The influence on society, progression, and evolution continuously increases our knowledge of the world and ourselves. The story of our past is revealed in our present, but also our present plays a major role in our future. An example of the past in our present is the night sky, for those stars are now no longer in existence. We now look at our fears that are closer to home and this is where our desire for a better way of life begins, the possibility of progress and how we conceive a better world.

There are currently three versions of how man will meet the end of existence. Firstly that in 5,000 million years our sun will evolve and become larger and hotter, making it impossible for life on earth to survive and we will return to dust. The second is that of the Big Crunch, when the universe will collapse back on itself. The third is the real danger, where we will potentially destroy ourselves, so that even before the first two occur mankind will already be extinct.

Darwin stated that self-reproducing organisms are different in terms of genetic material (nature) and upbringing (nurture) and the difference can be the key to being able to reach the correct conclusion and act accordingly resulting in survival. This is true long ago but scientific discoveries now take us to a new level of learning and development.

No one is content to accept that we exist because we exist. Man's deepest desire is to know the meaning of life and, now that we understand that past, present and future are linked and have a natural balance. Inevitably, we are here for a limited time yet we still strive to find the answers. In conclusion we need to help ourselves in the little time we have left.

Stephen Hawking became the first quadriplegic to experience weightlessness on a zero-gravity flight in April 2007 and stated before the flight "I believe that life on Earth is at an ever increasing risk at being wiped out by disaster such as sudden global warming, nuclear war, a genetically engineered virus or other dangers. I think the human race has no future if it doesn't go into space. I therefore want to encourage public interest in space"

Today people need to recognise that everyone counts and knowledge is power so the more knowledge everyone has about our world the more impact we can have.

## **Conclusion**

There may be many reasons why Professor Stephen Hawking wants to bring space and time to the masses but after my research I feel that it is to help us make the improvements for a better future for us all.

One of the questions I asked myself is, past or future, which is the more dangerous to ignore? Is history a road map to the future or is the future mapped out differently? Stephen Hawking has taught me that the past and the future are interrelated, one cannot exist without the other; you cannot learn about the past without looking towards the future and you certainly cannot look to the future without knowledge of the past.

There have been many debates over a creator or the big bang theory but Hawking, even as a scientist, never rules out a creator. He merely states the creator could have chosen when the big bang could have occurred. He therefore does not have all the answers to how our existence will come to an end. He is sure however, our eventual extinction is inevitable and to survive we must learn to plan for all mankind as part of planet earth.

Perhaps this is the start to a better life idea for which many of us are waiting for. It includes the possibility of progress and how we conceive a better world now that we understand that past, present and future are linked and have a natural balance.

This is why I think that, with Global warming or the threat of nuclear war, we have to start taking better care of each other and the planet we live on by recycling and reducing carbon footprints. These are the tools for a better world.

If we don't start acting now and simply rely on technology to get us through our own mess, then we might not get to develop such equipment since our future depends on the way we act now. Even a brilliant mind such as Stephen Hawking cannot deny that we may not have a future on earth unless we all play our part.

## **Evaluation**

This assignment was one of the most demanding tasks I have ever done. I am pleased with my project yet if I had my chance to start again I would have chosen someone different.

Stephen Hawking is a hero but his work is very difficult to prove since it is all based on theory and there is not enough evidence to demonstrate and explaining what Stephen Hawking's research and lectures are about is certainly not an easy task itself.

I feel that I could have researched Stephen Hawking a lot better by using fewer web sites to gather my information. I also had to read "A Brief History of Time", which took up a lot of time before I could even get started.

The answers to my questions were not what I expected; I thought perhaps I would get more definitive answers yet instead of searching for some superior knowledge of the past or future I found myself bothering about the present and what the world needs until some other brilliant mind comes along and transforms our technology taking us into a new tomorrow.

Although theoretical cosmology and quantum gravity are subjects that you would not go out and buy a book on and read at your leisure, nor something you would think could hold your attention for more than five minutes, this project has confirmed my view of Professor Stephen Hawking as a real hero of today. He has great skill in communicating his ideas by using different analogies combined with his wit can make the unexplainable comprehensible.

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## **Picture of Goldfish**

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## **Formula of Black hole**

<http://library.thinkquest.org/C007571/english/advance/core8.htm>

*Cartoon picture of a black hole*

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## **Singularity picture**

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