HOW WOULD, **AND SHOULD** WE PREDICT THE END OF THE **UNIVERSE?**

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1.0 - Abstract

This essay uses the current advancements in astronomy and quantum mechanics to outline and analyse the future scope of the universe's future as how these predictions may affect society. I have provided a preliminary explanation of the current projection of the acceleration of the universe, as well as a baseline introduction to modern methods of scientific observations outside of our Earth's atmosphere. During this project I have researched the methods of modern astronomy and its related apparatus, as well as how quantum mechanics and quantum theory is used as proof behind these endeavours. I also concentrate in topics such as the acceleration of the universe and the presence of dark matter and how this significantly aids us in a myriad of aspects; specifically, in the likelihood of already existing theories occurring and whether factors may increase the likelihood of one over the other. I have explored this topic from a technological, ethical/social, and historical perspective to fully analyse the extent to which we can predict the end of the universe and what psychological effect a certain prediction would have on humans. Ultimately, I have concluded that the end of the universe cannot be pinpointed specifically due to a variety of contrasting factors, as well as explaining how such information that could impact humans negatively would be futile, considering the trajectory our Earth is headed on considering climate disaster.

2.0 – Introduction

In Norse mythology, the end of the world was deemed to be Ragnarök, Old Norse for 'Doom of the gods', and would precede with cruel winters and mortal chaos. The Ancient Greeks and Romans believed that all of time was split into five periods – golden, silver bronze, heroic and iron. In 2800 B.C., the Assyrians warned that the end of the world was near. Mayans predicted the apocalypse for December of 2012. As a society, we have developed a cultural fascination with the end of time, the end of the world, apocalypse. In this main discussion, the 'end of the universe' means the natural end of our universe, which may be long after our time on Earth or solar system comes to an end. As a race, we would likely not be where we are today, for better or for worse, without tales of the apocalypse, and the development of astronomy. Quantum physics, however, has revolutionised science more recently and has brought a depth of definitiveness to this seemingly philosophical topic. In my extended project, I will be exploring how, and whether we should research and predict the end of the natural end of the universe. Through this project, I aim to gain a deeper understanding of the aspects of quantum physics and explore not only these topics, but also astronomy, ethics, and patterns of psychology within society.

I also have an intense interest in quantum physics, and as this modern field is constantly adapting to new research and evidence, these predictions to large questions, such as the end of the world, are quick to change also. Given artificial intelligence is an integral part of technological advancements and will play a vital role in the use of technology in the future, I would like to identify past possibilities in how the universe will end, and then analyse why they were theorised to begin with and then proven wrong.

2.2; Background

What would you do if you could predict the future? We as humans decided long ago that we could not predict the future, that it was merely outside our range of abilities. Less than 60 years ago, we as humanity reached the moon. 100 years ago, we had just created our current atomic model, and before that, we used the human eye to etch the sky and beyond. Now, we try to predict

2.3; Research review

In my research I have referred to a range of sources, including books, technology product reports, and online websites. Because my project is predominantly focused on the technology sector, there seemed to be more resources available online, however I did keep in mind to find sources that are as recent as possible due to the information in this field evolving frequently. When referencing each source, I took time to consider if they take a biased stance, and what their purpose is whether if they intend to educate, inform, or persuade.

1) Nature.com, Ball, P. (2020) *From big bang to cosmic bounce: An astronomical journey through space and Time, Nature News.* Nature Publishing Group. Available at: <u>https://www.nature.com/articles/d41586-020-00356-2</u> (Accessed: October 1, 2022).

Nature wrote an article about the theory of space and time, named 'From Big Bang to cosmic bounce: an astronomical journey through space and time'. This source of this article is 'Nature', a multidisciplinary science journal. *Nature* can also be named credible due to its origins being founded in 1869 and thus far being held as credible. To publish false information or unreliable sources would not stand against its scrutiny of being one of the world's most read academic journals. This makes the page's source, *Nature*, a fairly reliable and trustworthy source. For the page itself, the title is simple and not biased. Although the title is a bit flourishing to entice the reader, no external bias is forced upon the reader or implies false information. Furthermore, this article was published in February of 2020 – while the time limit for sources in this field is shorter due to information rapidly evolving and changing, all information still appears to still be reliable due to no updated information seeming to be present. However, this page was found in the 'book reviews' section of the website. This could hinder its reliability and ultimate usefulness to my research because while it may provide useful insight, the article is critiquing the book and its author - the focus is not on providing direct information to the reader on this topic.

2) NASA (https://www.nasa.gov/) Accessed: October 1, 2022

National Aeronautics and Space Administration, hereon known as *NASA*, is a U.S government agency responsible for Space related technology and research. Its origin implies that it is a robust and secure site, as the NASA corporation is a part of the US government agency. Furthermore, it is one of the most well known and trusted company since space exploration even began, and so must stand up to its extreme scrutiny. A specific piece I used was about a new piece of technology, (see https://www.nasa.gov/feature/goddard/2019/nasa-s-wfirst-will-help-

<u>uncover-universe-s-fate</u>). The author of this article is written by Ashley Balzer, who has worked for 3 years to date as a science writer at the *NASA Goodard Space Flight Center* and employs very objective information with little to no opinions. The report also provides detailed information consistent with current trends and research, as well as being written and structured in an academic format with the intention to inform. Overall, I have used this report as it seems to be an accurate and non-biased source of information to spread awareness about how using infrared telescopes can measure levels of dark energy and give us a more in depth sense about the universe's age.

3) National Library of Medicine

Anand, N. et al. (2022) Doomsurfing and doomscrolling mediate psychological distress in covid-19 lockdown: Implications for awareness of cognitive biases, Perspectives in psychiatric care. John Wiley and Sons Inc. Available at: <u>https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8250995/</u> (Accessed: October 7, 2022).

The National Library of Medicine, (hereon referred to as NLM), had published this article online in January of 2022. While it is more scientific and uses precise language, I have found this vastly useful for the formulation of my ethics discussion of space exploration, using the recent COVID-19 pandemic as an example. The NLM, founded in 1836 and first moving online in 1993, is the world's largest centuries. It is a subsidiary of the National Institute of Health (NIH), and thus stands up to extreme scrutiny. A false or misleading article would therefore not be published to maintain its reliable reputation. While reading the article, I noticed that key information such as the author information, date of publication and associated data are presented at the top of the article, giving easy access to anyone who may be wary of this information to critique and check the reputability. Of the nine total authors, all of them have attended further education in the neurology or psychology the key topic that this article covers and are forerunners in their field with reputable credentials. The articles structure is clear and its abstract, references and main discussion are labelled clearly, as well as gives specific details through objective and astute language. Colloquial language is referenced in the title as 'Doomsurfing' and 'Doomscrolling', however is not a result of informal language in an educational manner and the condition that the article is written on encompasses the new term.

4) The End of Physics

The novel *The End of Physics* by David Lindley was published in 1993 and discusses the history of attempts to develop an all-encompassing theory of all science. This book was published primarily for educational perspective in physics and philosophy, however because all authors seek for their novels to gain popularity, also likely crafted to increase consumption. David Lindley an accredited British theoretical physicist that holds a Bachelor's Degree from Cambridge, who provided a brief history of key physics investigations and the philosophical implications of the 'End-all and be-all' scientific theory. The novel is based on Dreyfus' philosophical opinion and published by Basic Books, which is a global publishing company that specialises in philosophy, history, and current affairs. Based on these acclaimed origins, this novel is likely an accurate source to reference. Despite the old publishing date, the contents of the book are valid and useful to my research because of the phrase used, 'The Myth of a Unified Theory'. The book goes into the philosophical side of the true use of physics and inspired me to add a further range of philosophical depth to my main discussion as I debate whether my topic is even worth exploring - metaphorically and physically.

2.4; Key terms and acronyms

AMS-02 – the Alpha Magnetic Spectrometer, a particle physics detector aboard the international space station that searches for antimatter and dark matter and measuring cosmic rays (European Space Agency)

Astronomical unit – a standardized unit of length equal to 149 597 870 700 m exactly, used for convenience in expressing distances of objects in the solar system (International Astronomical Union)

CMBR – Cosmic Microwave Background Radiation, low level electromagnetic radiation filling the universe that is a residual effect of the big bang (Britannica)

Dark energy - hypothetical form of energy that produces a force that opposes gravity (Marriam-Webster n.d.)

Dark matter – a component of the universe who is not luminous, so its presence is decided off its gravitational attraction (Britannica)

Existentialism – a philosophy which stresses the importance of human experience, and says that everyone is responsible for the results of their own actions. (Collins Dictionary)

Hubble space telescope – the first permanent observatory aboard the ISS launched in 1990 (NASA)

Interferometers - an instrument that works by merging two or more sources of light to create an interference pattern, which can be measured and analyzed; hence 'Interfere-o-meter' (Caltech)

JW telescope – James-Webb telescope, a high-level infrared observatory telescope launched in 2021 (NASA)

Redshift – displacement of the spectrum of an astronomical object toward longer (red) wavelengths, attributed to the Doppler effect (Britannica)

Spectrographs – an instrument for detecting radiation into a spectrum (Marriam-Webster n.d.)

2.5; Rationale

Quantum physics is one of the most unknown fields in the world. Other fields have a plethora of research and knowledge; however, the undetermined aspect of this field is what makes it so interesting. Space exploration is one of the most everchanging fields in our current time, fuelled especially by competition between privatised space companies. The reason I chose to do this is because. Furthermore, my interest in space exploration and quantum physics has made this specialised research into a continuously updating industry so important for me. Space exploration has had many complications and ethical dilemmas and branching on those have allowed for ethical discussions to be written in my main discussion. I intend to learn and further research into how both quantum research and space exploration will transform the science and space industry, as well as gain an ethical perspective on why humans have pondered and valued 'the end of the universe' – allowing me to gain a deeper perspective on how such knowledge would impact society.

3.0 - Main discussion

3.1; Brief history of space exploration since the International Space Station (ISS)

The first rudimentary station was created in 1969 by the linking of two Russian Soyuz vehicles in space, followed by other stations and developments in space technology until construction began on the ISS in 1998, aided by the first reusable spacecraft from the United States' shuttles. The project, which began as an American effort and originally named Freedom. This led to the merging of Russia and the United States' separate space stations merging into a single facility, integrating their respective technologies and modules. Later, additions from Canada, the European Space Agency (ESA) and Japan were made, marking the ISS as an internationally peaceful research hub in Earth's low orbit. The International Space Station was a key turning point in space exploration – an orbiting laboratory revolving around the Earth where long term exploration and research of space is carried out. A stable and international base that can hold research equipment and long-term experiment can be carried out has allowed for various scientific breakthroughs to occur. The research has aided humanity both in space exploration and to improve quality of life on Earth through scientific breakthroughs, such as cancer research through the National Lab sponsored PCG-5 study and monitoring heat safety on Earth from an outside perspective. Recently, the The Alpha Magnetic Spectrometer (AMS-02) was launched onto the ISS May 20211, which looks for dark matter and antimatter.

3.2; How we are currently measuring the universe's future

While measuring the universe is a broad topic. The Hubble Space telescope has multiple functions specifically for analysing the universe, for example cameras, spectrographs and interferometers². Using research from telescopes and the ISS, professionals have calculated the density, age, and speed of the universe. There are also more specific measurements such as the astronomical distance between certain bodies, gravitational field strength in certain areas and the presence of substances such as dark matter. However, it is impossible to predict the future, only the likelihood of certain outcomes occurring. To predict the most likely path of the universe is calculated using the

¹<u>https://home.cern/science/experiments/ams</u>

² <u>https://www.nasa.gov/content/goddard/hubble-space-telescope-science-instruments/</u>

acceleration and expansion rate of the universe, one of the most prominent measurements for determining the fate of the universe.

Telescopes have improved significantly over the last several decades, especially with the recent launch of the James Webb (JW) telescope in December of 2021, and alongside its 18 hexagonal reflection plates for in depth imaging, it can also detect infrared wavelengths. One of the key methods now is image capturing of distant galaxies, that are so far away from us that the light, that forms the image that the telescope sees now, has taken billions of years to reach us. The JW Telescope allows astronomers to look backward in time essentially, to the near beginning of what we classify as time.

3.3 The beginning of the universe

The topic of 'the end of the universe' implies that there was a beginning to the universe, which we refer to as the Big Bang theory. Presence of Cosmic Microwave Background Radiation (CMBR), the acceleration of the universe and has tested the Big Bang theory to be correct to an extent. Despite this, we cannot be completely sure about the beginning of the universe and how it began, only the likelihood of a scenario occurring. The Big Bang theory says that the universe came into being from a single, unimaginably hot and dense point³, a singularity. The universe didn't occur in an already existing space and rather, it initiated the expansion and cooling of space itself. This has led scientists to wonder whether vice versa could occur at the end of our universe – a gradual freeze until a sudden heating up and gaining a gravitational force so strong that the entire universe is compacted into one specific point again, much like the formation of a black hole.

3.3 Acceleration of the expansion of the universe

The acceleration and expansion of the universe is key to understanding if the universe would end, and how. If the universal was experiencing significant disinflation (still expanding but at a significantly slower rate), it would someday stop and reverse itself, ending in a hot Big Crunch. Redshift of distant galaxies are measured over a period, and the rate of this redshift allows astronomers to predict the expansion of certain parts of the universe, due to Hubble's Law. Hubble's law states that the distance of a galaxy from our own is directly proportional to the rate at which they are moving away from us; the further away it is from us then the faster its moving away as well. However, the universe

³<u>https://thesciencebehindit.org/how-did-the-universe-begin-how-will-it-end/</u>

has no centre, so our own galaxy is not on a fixed point, every galaxy is moving away from each other.

Between the 1980s and 90s, two separate teams set out to find evidence for the acceleration of the universe using distant supernovae. Large telescopes were used to take deep images of various parts of the sky, repeating these same fields a few weeks later. They found possible supernova among the galaxies, and by repeatedly imaging these supernovae, they measured the galaxy's peak brightness. The data that these astronomers accumulated implied that the expansion has been accelerating in the past 5 billion years. Furthermore, later measurements revealed the era of deceleration during the first 9 billion years. Other techniques have now confirmed this acceleration, which most astrophysicists attribute to the presence of dark energy of unknown origin.

Recently, NASA's Hubble Space Telescope discovered that the universe is expanding, 5-9% more than expected, and the updated Hubble's constant as of June 2016 is that the improved Hubble constant value is 73.2 kilometers per second per megaparsec, where the distance between cosmic objects will double in another 9.8 billion years.

3.4; Popular predicted outcomes for the universe's natural end

Despite great lingering uncertainty, physicists have narrowed down all possible outcomes for the natural end of the universe to three plausible theories: the Big Crunch, the Big Rip, the Big Freeze.

The Big Crunch theory predicts that while the universe is currently expanding, it will not forever. At a certain point in time, the universe will stop expanding and instead collapse in on itself, pulling in all matter in the universe in with it. This process will continue until all matter is compacted into a small area, essentially becoming a black hole. A key parameter to this theory is the density of the universe. It is believed that if the density of an object is larger than a certain value, the critical density, then an eventual collapse is more likely. The Big Rip occurs when the opposite to the Big Crunch occurs, and the universe continues to expand. At this point, the acceleration of expansion would be so great that objects within the universe would start being pulled apart, starting with galaxies being torn apart and ending when atoms themselves disassemble and disintegrate. The Big Freeze, also referred to as the Big Chill or Heat Death, predicts that as the universe expands, the matter will be dispersed too far apart. As a result, the formation of stars would stop from lack of matter, used as fuel, and galaxies would also stop growing, from the lack of stars. As a result of this, all the energy and heat in the universe will eventually become evenly distributed, plateauing at an all-time low temperature.

Some theorists believe that a Big Crunch may spark another Big Bang, resulting in an infinite loop of the universe's expansion and collapse. Astronomers once agreed with near certainty that the universe could collapse in a Big Crunch, however now the assumed outcome is a Big Freeze. The Big Crunch theory was widely believed until 1998, where an entity named dark energy, produced its own additional gravitational force. The presence of dark matter has appeared to cause the expansion of the universe to accelerate even more. As the Big Crunch possibility relies on the expectation that the universe will stop acceleration and collapse inward, the presence of dark matter makes indefinite expansion more likely and thus the Big Crunch theory is no longer [popular].

However, the discovery of dark matter and energy was a crucial turning point for scientists' beliefs on which outcome is most likely. Dark energy makes up 68% of the universe's total mass, with dark matter being a further 27%. All normal matter, essentially all we have been able to observe with telescopes, takes up 5%. This steep ratio means that the universe's expansion will never slow down, only accelerate. In addition to this, a study by Marcelo Disconzi of Vanderbilt University in 2015 determined that the universe's viscosity is low enough for it to expand to an infinite size. When combined with the prevalence of dark energy, how it will continue to increase in strength and eventually overtake the force of gravity. For these reasons it is suggested that the universe's possibility now is the Big Rip, as the universe appears to continue to stretch itself and expand apart until it consists of nothing.

3.5 Philosophy of 'the end of the universe'

The ethics of this are interesting as well. The 'Paradox of predictability' by Michael Scriven, states that everything in a deterministic universe is, in principle, predictable; second, that it is possible to create a system that falsifies any prediction that is made of it. In theory, if the end of our universe is part of our determinable universe, such as how death is a determinable part of life, then it is in fact predictable. Advancements in space exploration and metaphysical calculations have allowed us to make predictions and theories about the determinable end of our universe. If this process continues then eventually a true theory will be discovered, it is only a matter of whether scientists realise that they are correct at that point in time. Eschatology, the study of expectations regarding the end of human history or the world itself, has been present in humanity since the earliest civilisations and religions.

3.6 The psychology

We as humans appear to have an innate curiosity and fascination with end of the world, also referred to as doomsday. Linking this to fascination with space exploration, humans

have pondered these metaphysical queries before it was even labelled. Humans appear to be fueled by the intangible desire to explore and challenge the boundaries of what we know and where we have been for centuries. However, while the end of the world was a common theme, its prevalence in media has grown significantly. Stanford researcher Angela Becerra Videgar says that human's fascination with zombies and it's popularity in media can be traced back to the use of nuclear warfare in World War II. Using this information, it can be hypothesised that the same occurred when the space race was launched out of fear of opposing countries spying on one another. This in turn caused space related futurisms and conspiracies began to arise, however as technology evolved, some of these theories began to prove true. The addition of violence in media, including gore content shown to adolescence in video games, have caused a lot of doubt about the consequences of our development as modernized societies, and "instead we are left with this cultural fixation on fictionalizing our own death, very specifically mass-scale destruction."

Doom scrolling, the act of spending an excessive amount of screen time devoted to absorption of negative news*. The end of the universe is deemed rather negative and alongside with the plethora of doomsday-themed media that is prevalent today creates an atmosphere or impending doom, especially in the recent pandemic events, and makes apocalypses a common discussion point. Contrary to this, doomsday is not as large of an issue as we predict it to be, at the very least compared to the climate crisis that may perish humanity first. The end of the universe is very likely to end much later than humans will go extinct or evolve into a new and indistinguishable species. The earliest occurrence of the Big Rip, for instance and under specific, is 22 billion years. It has been estimated that modern humans have already been through half the duration of human history. John Richard Gott III, an astrophysicist who's contributed to the Doomsday Argument, has formulated that humans will go extinct in 7.8 million years*. In the prospect of doom scrolling causing elevated levels of anxiety, at the very least the educated guess that humans will not be alive to witness the end of the universe may be comforting, and rationally would not cause panic if how the universe ends, if firmly decided on.

Despite human's rationally not needing to worry about the end of the universe, as we or our descendants will not be alive to witness it, the media may percept this scientific discovery to quickly cause mass panic. Fake news, news stories that are composed of falsified information with no verified sources and intended to spark a certain emotion, commonly takes scientific discoveries, and uses the general's population lack of understanding in a certain field to convince them of a certain false outcome. This phenomenon has become increasingly more prevalent in today's day and age, where information is created incessantly. During the beginning of the COVID-19 pandemic in 2020, fake news, regarding the origin of the virus, symptoms, death rate and fast remedies took up the population's knowledge regarding the virus in absence of true, scientific information. Evidence presents that fake news was even brought into national headlines to promote certain political agendas and parties. This caused mass panic in the form of increased levels of anxiety and paranoia, stockpiling and panic buying of necessities and racist. The dire consequences of misinformation from the COVID-19 pandemic show how society may be impacted if something as seemingly tragic as knowing 'how the universe will end' becomes falsified online, as 'end of the universe' and 'end of the world' are similar phrases, where one affects humans more than the other.

3.7; Ethics of predicting the universe's fate

Despite several arguments for determinism, space exploration and physics have sparked contempt. The ethics of prediction and determination focus on whether prediction benefits its beneficiary. Much like the prophecies told to heroes in Ancient Greek myths, the tragic hero often meets their demise soon after being told their fate. Despite rational thinking regarding doom scrolling, finding the answer to this query is likely to spark irrational worry than actual benefits. Moreover, what is the point of investing time, resources, and minds towards this issue if we would not be alive to witness it? There has always been the issue since the beginning of space exploration of opportunity cost regarding the sizeable budgets allotted to space exploration, when that funding could be used to solve critical issues in our society on Earth instead of searching for an indeterminable solution. There are no clear benefits to determinism on this wonder, however this could be proved otherwise. Just like how scientific method, is where it is today thanks to prehistoric astronomy, this seemingly futile journey could prove massively useful in the future in ways we cannot predict.

4.0 Conclusion

Throughout my research I have conclude that the end of the universe can be predicted and should be researched due to the lack of presumably negative impacts it may have on society. As the astronomy and quantum physics field continues to make advances in space exploration and the presence of extra-terrestrial matter, we can have a deeper insight into the Earth's past and how it began as well as the layout of our universe. As we continue to explore into and beyond our galaxy in research of knowledge about the universe, we gain a deeper understanding about the mechanics of our universe and its components, in the form of more advanced researching tools and therefore, scientific discoveries. In current time where environmental issues become more dire and finite resources begin to run out, space exploration is becoming more necessary by the day to find new solutions and resources. The existentialism of this topic greatly intrigued me, as a discovery as definitive as this would fundamentally change entire concepts of philosophy and test human's response to seemingly negative news in the face of media distortion; possibly strengthening society as we know it. Evidently, the stages leading up to discovering this will play a key role in the quantum technology and physics, but once announced, will change how we as humans will react to negative news as profoundly as it is expected, which in turn will manipulate almost every sector and workplace.

5.0 Evaluation

5.1 Reflection

One area which I did not anticipate being as prevalent was the ethics of sharing a discovery such as this and the impact on society, however, I have explored negative perceptions of 'doomsday' portrayed by media and understand the impact that misinformation, purposeful or not, can have on the mental health of humans. This differs to my original stance because I now understand the extent that developments in quantum physics can lead to significant changes in humans. Ultimately, I have gained a deeper understanding of both quantum physics and astronomy, as well as discovering similarities between philosophy and quantum physics, which I found greatly enjoyable.

The most challenging aspect I found was accurately writing my findings in a clear and concise manner. With this field and topic, there is a plethora of information to write about and as it links to closely into philosophy and ethics, one can write lots and cover very little. To avoid this, I focused on reading as much as I desired to gain a broad spectrum of opinions and information, but only adding purposeful research into my notes to cover. Contrastingly, this is the greatest skill that this course taught me, and one that I will continue to employ in future academic writings. If I were to do this course again structured research would be my focus as they ultimately are the key to developing, clear links between points and writing a well-structured main body. I found that I had seen an improvement in my practical work skills such as time management, research skills, referencing skills and writing in a more academic style, which will aid me with any academic writing I write in the future.

5.2 Further study

I believe that my research would be particularly useful in academic and scientific fields, primarily in higher education for physics. This is because I answer a common but rarely answered question in a scientific manner, which would be useful as further study for a course in quantum physics or astronomy. I am greatly interested in quantum physics and engineering and intent to study it at university level. As I am not available to resources such as scientific telescopes for astronomy, or other scientific apparatus that may have aided me in practical research, that is further scope for study that I would enjoy pursuing.

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7.0 Appendix





CURRENT THEORIES



candidate number:



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