How Advanced Technologies in Astronomy Affect Human Mythology and Beliefs

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Astronomy, the study of the heavens and its motions, is humanity's oldest natural science. It has been a topic of great interest to mankind since the start of recorded history, with many of our ancient great thinkers, such as Plato or Aristotle, being intrigued by the science. Even before this—before it was a science—astronomy was one of the primary fascinations of mankind and motivations behind its mythologies. Paintings and monuments left behind by prehistoric civilizations showcase the wonder with which humanity viewed the stars, or the fear and awe with which humanity observed eclipses and solstices. By looking at ancient structures such as Stonehenge in Europe, remains of civilizations such as the Maya in Central America, and star catalogues of the ancient Chinese, one can see that astronomy has clearly had a vast and significant impact on humanity throughout history and across the globe.

This impact, however, has varied considerably between regions of the world. Though every culture and society in history would have been observing the same night sky, generally speaking, the interpretations of such observations almost always differed in both large and small ways. For some, the stars were their people's ancestors. For others, the stars were storytellers, describing adventures and legends of heroes fighting monsters. More differences can be found in astronomical interpretation across cultures in almost every aspect of astronomy. The one similarity that can be found, though, is the fact that the stars, planets, sun and moon, and nearly everything else in the sky always influenced the beliefs and mythologies of the culture.

The influence of these observations on a culture's mythology began in a time without advanced astronomical technology—all observations were naked-eye. As a result, one can expect to see many changes in how astronomy affects humanity's beliefs over the course of history as technology improves and leads to better understanding of astronomical observations. In this

paper, I will be using the Social Construction of Technology (SCOT) framework to explore this relationship between technology and mythology. This framework, developed by Trevor Pinch, a Professor of STS at Cornell University, and Wiebe Bijker, considers the relevant social groups that are involved in the creation, advancement, and use of technology (Pinch, 1987).

Part I: A Brief History of Technology in Astronomy

From naked-eye observations to radio telescopes and space shuttles, technology in astronomy has come an incredibly long way. In this section, I will be describing a few notable technologies and techniques that have come about because of astronomy. These technologies and techniques are obviously not exhaustive when it comes to the tools used in astronomy, however I believe them to be some of the most important when it comes to considering the influence on mythology and beliefs.

Observation

As astronomy is humanity's oldest science, it is no surprise that observation, one of science's simplest techniques, holds a fundamental place in the history of astronomy. Because of this, observation is arguably the astronomical tool that has undergone the greatest amount of change throughout history. It began with mere naked-eye observations—people simply looking to the night sky and seeing what they could with their own eyes. For millennia, this was all there was to astronomy, and this would remain largely unchanged until the 17th century and beyond.

It is worth noting that the majority of humanity's mythologies and beliefs stem from this time of exclusively naked-eye astronomy. The wonders of the night sky, the motions of the stars and planets, and phenomena such as the Northern Lights could only be understood as well as an

individual could see them. Naturally, one would expect this to be the cause of the vast differences in interpretation of observations across cultures.

As previously stated, advances in observational astronomy was largely stagnant for thousands of years. As humanity began to advance technologically, particularly in Europe in the 14^{th} – 17^{th} centuries, observational tools and techniques became more powerful. This revealed the fact that the sky was much larger and contained immeasurably more than ever thought before. Other planets were discovered, moons around those planets became visible, and supernovas and other celestial events became much more apparent. Things that were once only matters of speculation could now be studied and understood.

Navigation

Another area of astronomy that remained largely unchanged for centuries, is navigation. For many cultures and societies throughout history, exploration at sea was perilous due to it being nearly impossible to navigate. Land exploration was easy enough—landmarks, roads, and maps all attributed to a much lower chance of getting lost when exploring or travelling. The open sea, on the other hand, gave no such assistance. Even the night sky offered limited help when it came to navigating the sea. Constellations and specific stars, the North Star Polaris in particular, could aid travelers and explorers when it came to cardinal directions. However, this was rarely sufficient to determine one's precise location—something that was critical for navigating uncharted territory.

It wasn't until the invention of the sextant and other angular measurement tools that humankind was able to safely traverse wide expanses of the open sea. By taking angular measurements of a celestial body, usually the Sun or Moon, and the horizon, sailors can

determine their latitude and longitude—this is called celestial navigation. With this, explorers were able to keep track of their location while sailing across the Atlantic Ocean or on other long naval voyages. This angular measurement technique would be the primary method of navigation for centuries. In modern times, we are able to use GPS and other satellites to determine precise locations.

Telescopes

Arguably the single most important technological innovation in all of astronomy is the telescope. This invention is often attributed to Galileo Galilei in 1609, however the first telescopes were in fact created in the Netherlands by Hans Lippershey, Zacharias Janssen, and Jacob Metius a year before Galileo in 1608 (loc.gov). The invention of the telescope was a monumental event in the history of astronomy. With it, observational astronomy was able to become more than just naked-eye observations.

This invention paved the way for incredible discoveries over the next several decades following its invention. The first few telescopes allowed Galileo to reveal the presence of Jupiter's moons, now named after the astronomer himself. Imperfections in the moon, once thought to be a perfect sphere, were discovered. Sunspots were seen for the first time, showing that the Sun was rotating and also imperfect. Countless other new celestial bodies were discovered, and those existing were now being observed closer than ever before.

The telescope would undergo several important improvements and advances over the centuries. The original telescopes showed astronomers the wonders of our solar system. Modern-day telescopes like the Hubble Space Telescope show us the complexity and beauty of our galaxy and galaxies beyond. From refracting to reflecting telescopes, visual light to radio,

telescopes have come in many different variations and have been invaluable in the advancement of our understanding of the cosmos.

Space Travel and Exploration

This area of astronomy is incredibly young compared to the previous topics discussed. While observational astronomy has been around for millennia and telescopes and celestial navigation for centuries, space exploration is only a few decades old. The first artificial satellite, the Soviet Union's Sputnik 1, was launched 63 years ago on October 4, 1957 (NASA). This marked what many consider to be the start of the space age.

Throughout the 1960s and 1970s, the United States and the U.S.S.R would be locked in what is colloquially referred to as the "Space Race." This was a time of rapid advancement in the area of astronomical technology. Within the span of 12 years, mankind had gone from having nothing in space to putting a man on the moon with the Apollo 11 mission in 1969. This mission certainly had significant political, societal, and economic effects, however when looking at the event from a wider lens and considering what a monumental event the moon landing was in terms of humanity's progress as a species, astronaut Neil Armstrong's famous quote, "*That's one small step for a man, one giant leap for mankind*," becomes much more poignant. Mankind was just set foot where it had once thought was unreachable. What was once the domain of gods was now accessible.

Part II: A Brief History of Mythology's Influence on Astronomy

While the main topic of this paper is the influence that advances in astronomy has on humanity's mythology and beliefs, it is important to note that there is also influence in the other direction. From models of the solar system, to theories of formations of celestial bodies, to

modern-day names of planets and space exploration missions, the influence that mythology and humanity's beliefs has had on astronomy is very apparent. In this section, I will describe a few of the more significant examples of this.

Astrology

As previously mentioned, interpretations of astronomical observations have varied significantly across cultures throughout history. In some ways, these interpretations led to the development of a culture's mythologies. In other ways, a culture's interpretations were rather because of an already existing mythology. This can be seen in many different cultures, with Astrology being a prime example.

Astrology, in a broad sense, is the idea that meaning or predictions can be interpreted from the position of celestial bodies. This practice came about largely as an attempt to understand the will of a culture's deity or deities. Astrology has been around for millennia and can be found in the history of cultures across the globe. For most of its history, it was considered to be an academic subject, leading to advances in astronomy.

Constellations

Constellations have been a subject of wonder since humanity first began to observe the night sky. They serve as one of the best examples of humanity's mythologies influencing astronomy. While there are different constellations from various cultures, and the earliest constellations date back to prehistory (iau.org), the majority of those we refer to today are from the 88 International Astronomical Union designated constellations (iau.org). These constellations come from the ancient Sumerians and Greeks. They showcase various heroes, monsters, and other legendary creatures from those cultures' myths and ancient stories.

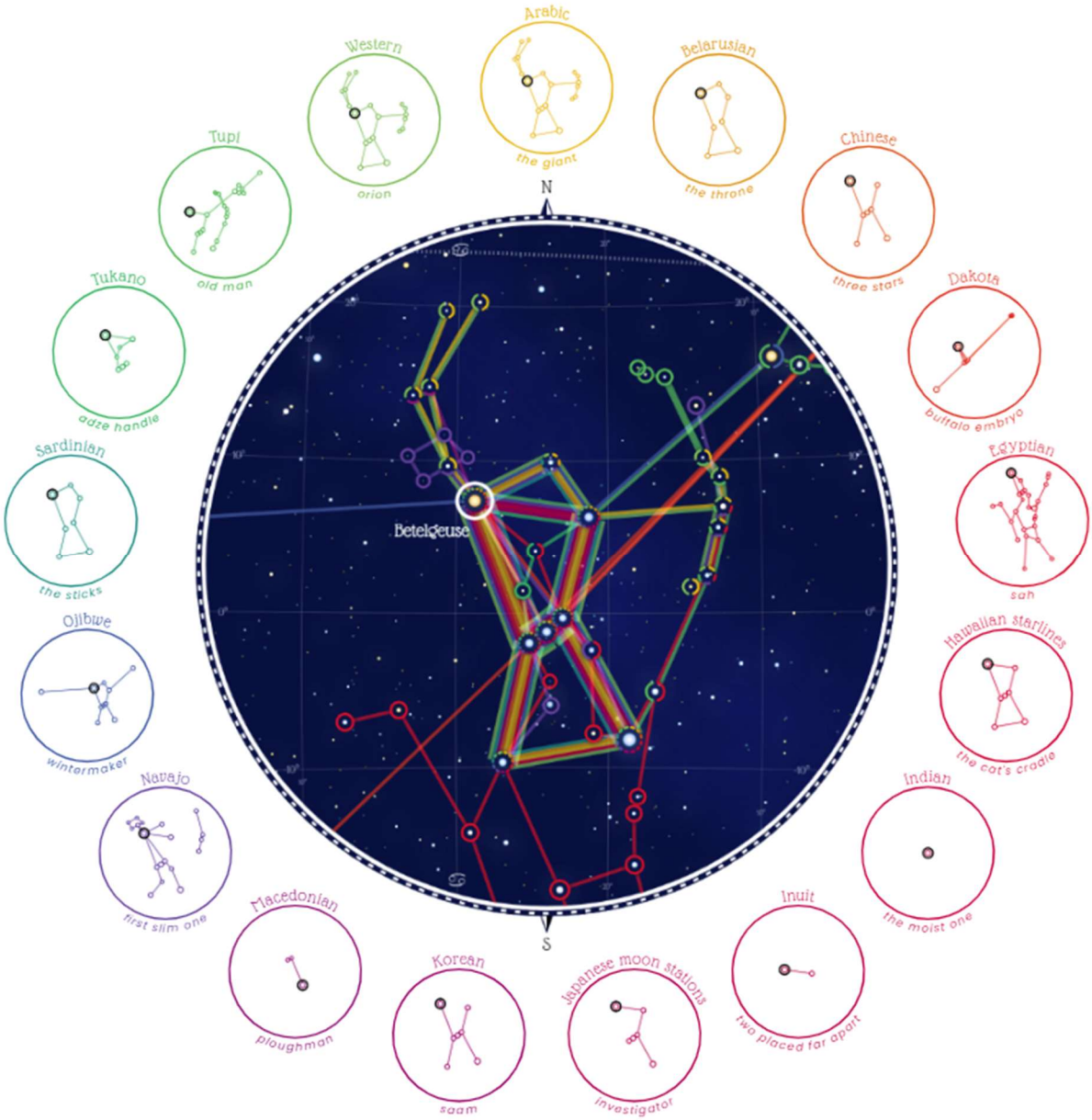

Figure 1: 17 different cultural interpretations of the constellation Orion (datasketch.es).

It is interesting to consider why seemingly every culture throughout history interpreted clusters of stars as images of mythological figures. Especially when one considers those constellations that do not particularly resemble the figure for which it is named, this practice seems to be unexplainable.

Celestial Models

Throughout history, humanity has frequently sought to understand the motion of the night sky. A large part of this has been attempts to create a model of the universe—or rather what was thought to be the universe at the time. Over the years, there were many different cosmological models proposed, with great thinkers such as Plato, Aristotle, Ptolemy, Copernicus, and more each creating their own attempt at explaining the motions of the celestial bodies.

Part III: Technology and Beliefs Conflicting

Throughout the history of astronomy, there have been many instances and time periods where technology and astronomical observations or theories have conflicted significantly with widely held beliefs of the time. Primary examples of this conflict can be found both as far back as ancient Greece and in modern day. In this section, I will highlight a few specific examples, as well as some more general cases in which astronomy has come in conflict with humanity's beliefs.

Copernicus and Galileo

During the 16th and 17th centuries, the Catholic Church wielded immense power within Europe. Despite this power—or perhaps because of it—the Church was obsessively concerned with the threat of heresy and contradictions of the Bible being spread. Scientists who disagreed with the Church's interpretation of the Bible would be persecuted and have their work forbidden. This caused immense discord between religion and science.

One of the best-known examples of this conflict between the Church and science is the proposal of a Sun-centric system by Nicholas Copernicus in his book *On the Revolutions of*

Heavenly Bodies in 1543. This model of the cosmos was in direct opposition to the Church's Earth-centric model. As such, it was deemed heretical by the Catholic Church.

A few decades later, Galileo Galilei wrote his book *Dialogue on the Two Chief Systems of the World, Ptolemaic and Copernican* in which he defended Copernicus's proposal. This led to the Pope labelling him a sinner and prohibiting copies of the book from being published, as this again went against the teachings of the Church at the time. This struggle between scientists and the Church would continue in some fashion for centuries and is even still evident today in some areas.

God of the Gaps

Copernicus and Galileo provide specific examples in which astronomy conflicts with humanity's beliefs. However, a more general example of this can be seen in the idea of "God of the gaps." This is a philosophical argument which points out the theological fallacy of explaining mysterious phenomena, or otherwise unknown areas that science cannot yet explain, as proof of God's existence.

This "God of the gaps" idea can be seen all throughout history and even today. Any example that uses a deity as an explanation for some astronomical phenomenon is likely an occurrence of this fallacy. Eclipses, for example, were once thought by some cultures to be caused by Sun and Moon deities. Due to the fact that we now know that eclipses are simply caused by the motions of the Earth, Moon, and Sun aligning properly, the "god" that was once responsible has shrunk. In other words, using a deity to explain something that is later understood through science serves to minimize that deity, showing that science and humanity's beliefs can often not work well together.

Defying the Impossible

In addition to astronomy being occasionally in opposition with religion, there are also times in which the science has proven secular beliefs wrong. As with any other science, hypotheses and theories rise and fall. Sometimes they are proven, sometimes disproven, and sometimes they are simply forgotten about or nearly dismissed from the start.

The latter is precisely what happened to Subrahmanyan Chandrasekhar, an Indian-American astrophysicist. Chandrasekhar had done extensive work on calculating the maximum mass of white dwarf stars. This limit, now known as the Chandrasekhar limit, is the mass above which a white dwarf can no longer resist its own gravitational pull. A white dwarf with mass past this limit will collapse in on itself, forming a neutron star or a black hole.

This idea was brought by Chandrasekhar to renowned British physicist Sir Arthur Eddington in 1935. Eddington publicly criticized Chandrasekhar's theory. This theoretical limit would later be proven correct with the first confirmed detection of a black hole in 1972. Chandrasekhar would later be awarded the Nobel Prize in Physics in 1983.

Part IV: Consequences and Effects of Disconnects Between Technology and Beliefs

It is clear that technology and scientific advancement have frequently been at odds with humanity's religions and beliefs throughout history. This is an unfortunate reality for many reasons and is something that, in some ways, continues today. While it is obviously too late to reconcile this conflict between specific individuals in history—as many of the occurrences of this conflict occurred hundreds of years ago—it is important to bring this to light and learn so as to attempt to prevent further conflict between very important parts of humanity as a society: science and religion.

Though they were certainly not the only scientists persecuted for their work, Copernicus and Galileo serve as two of the most famous examples of the historical conflict between astronomy and humanity's beliefs. It is unfortunate that these two, along with many other great minds throughout history, had to suffer simply because their findings and teachings did not align with the current widely held beliefs.

When thinking about the historical persecution of scientific advancements, such as with Copernicus and Galileo, the primary question that comes to my mind is this: how did this conflict between astronomy, and really science as a whole, and humanity's currently held beliefs affect those individuals who had potential to be great scientists? For example, imagine that Galileo were to have seen the persecution of Copernicus's work and decided against defended for fear of being persecuted himself. This would obviously have led to a much different history of astronomy. This idea leads me to wonder if humanity's advancements in technologies and astronomy may have been stunted to some degree by this persecution.

Conclusion

In this paper, I have highlighted areas of both astronomy and humanity's history of mythologies and beliefs. In some instances in history, the combination of astronomy and humanity's beliefs resulted in tragedy, as with the persecution of Galileo. In other areas, the consequences were not quite as severe. Overall, however, I believe that the influence that technology within astronomy has had on humanity's beliefs has been worthwhile, even despite the pain it occasionally caused. Without the advancement of astronomy, humanity would still be trapped in falsehoods and wrongful beliefs. Through inventions like the telescope, advancements in navigational techniques, and great and fearless minds like Copernicus, we have been able to disprove mythologies and beliefs that had been held for centuries.

Though at times astronomy and humanity's beliefs may seem at odds with each other, I believe it is also important to remember that human mythology has also had positive impacts on astronomy. As stated within this paper, human mythology can still be seen today in the names of constellations, planets, space exploration missions, and many other aspects of astronomy. This is inclusion of human mythology is a testament to how long this subject has been a part of our species.

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