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A History of Science in Latin America

### The 3 Models of the Universe

Throughout the course of Latin America's history, the question regarding humanity's place in the universe had initiated significant changes in beliefs and knowledge. The question highlights the narrative of Latin America's encounter with the three worldviews. The three being Biblical, Ptolemaic, and Copernican. These models had shaped the scientific and cosmological exploration in this area. Every single model that was presented had brought with it new understandings of the universe as religious and philosophical thought had influenced these models. The Biblical model was introduced initially through the colonial influence of Spain and this model laid their foundations on religious and educational contexts throughout Latin America. The Ptolemaic model was the model that emphasized a geocentric universe which was reinforced by the Catholic Church's endorsement allowing the model to deeply embed itself into the colonial cosmological beliefs at the time. Finally, the Copernican model was the model that created strides as this model encouraged and valued a spirit of inquiry. This model would challenge existing and prior beliefs and would eventually inspire Latin American scientists to further engage with scientific discussions of their time. The evolution from biblical to heliocentric models had created a wonderful opportunity for Latin America to change their perspective on science.

Each of the models had their own historical and cultural context which is what made the understanding of the three models so interesting. Spanish colonization in the early 16th century had introduced various ideas and knowledge such as the Spanish language, new forms of governance, and new religious and cosmological beliefs which were key to European Christian societies. The Biblical Model had dominated in this time period as missionaries and colonial authorities had spread teachings that believed the universe was created by God. This model had emphasized this divine plan that they had and how humanity plays a central role in it. This model wanted to establish a foundation set in religion with education and governance where there could be religious institutions that educated those in the region. To establish a socially and spiritually unified society, colonial authorities used the Biblical Model to try and develop an encompassing worldview that combined religion and administration. Education started to revolve around religion and the spread of cosmological ideas was supported by religious organizations. Early Latin American institutions and schools focused on teachings about a world created and governed by God, emphasizing a curriculum consistent with Church theology. In this sense, the biblical model influenced administration and education, creating an atmosphere where religious belief was closely tied to scientific understanding. This model's focus on divine creation and humanity's primary purpose created a framework that had a significant impact on literature, art, and daily life, supporting a belief that spirituality was essential to understanding society and the

universe. As the colonial education systems were introduced and established, the Ptolemaic Model made its way into the light within the Latin American intellectual community. At the time the Catholic Church was a dominant force in both education and governance so having their endorsement played a very important part in the validity of the Ptolemaic Model. The Church believed in the geocentric view as it aligned with the teachings of a universe that was centered around humanity and Earth. It reinforced the belief that the universe was created with humans in mind and that the Earth holds the most significant and pivotal place. Because of the Catholic Church's influence on governance and education, the Ptolemaic Model became widely accepted in colonial culture. This geocentric concept was included in the curriculum of early colleges and universities which influenced how students studied the universe and humanity's role in it. The Ptolemaic Model had useful applications that made it useful in everyday life as well as its theological significance. Its concepts were applied to navigation, an essential ability for a culture that was largely dependent on trade and transit by sea. Colonial Latin America's ability to communicate and trade with Europe was essential to its economy and their Ptolemaic astronomy-based navigational aids were crucial to preserving these ties. Because of this, the Ptolemaic model had settled itself into Latin American colonial thoughts creating an established worldview that included cosmology, navigation and philosophical thoughts in this developing society. In addition to cosmology, the Ptolemaic Model had an impact on philosophical viewpoints. This universe model matched the ideals of the colonial social structure, which was dominated by Spanish power and the Church. Colonial rulers and the Church had played important roles in society, much like Earth had a special place in the Ptolemaic universe. From the governing class to the common folk, everyone had a specific role in the system that was

supported by this worldview. As a result, the concept became integrated into the colonial mentality and helped defend European power and social structures as components of a divinely ordered system. However, as time went on, by the 18th and 19th centuries, scientific knowledge had spread widely. The Copernican Model had challenged these old beliefs and was an amazing example of the development of scientific thought within the Latin American societies. The model was heliocentric and came to be because of the hard work of Latin American scientists and intellectuals that were influenced by the Enlightenment idea as they were the ones that challenged these beliefs. In contrast to the Ptolemaic Model, the Copernican viewpoint placed the sun, rather than the Earth, at the center of the universe. By removing humanity, and therefore, Earth, from the center of existence, this unprecedented concept signified an important change. The heliocentric model, which was founded on careful observation and scientific thought opposed the religious interpretations that had previously influenced Latin American cosmology. In addition to representing a fresh perspective on the universe, this model also challenged the dominance of European knowledge and paved the path for fresh, independent scientific techniques. Many intellectuals found that the Copernican Model offered a means of challenging established views, allowing them to observe the world from a scientific viewpoint rather than a religious one. This had encouraged several thinkers and scientists to pursue self-guided approaches to science and the understanding of the universe. The Copernican Model not only signaled a change in scientific knowledge during this significant time, but it also influenced the intellectual identity of Latin America. The heliocentric viewpoint encouraged a spirit of self-reliance, independence, and exploration that matched the social and political goals of the region. Latin America's scientific and cultural independence began when its scientists and

intellectuals adopted this model, laying the foundation for a distinctive scientific methodology that blended local viewpoints with European influences. The Copernican Model contributed to the development of a culture of curiosity, resiliency, and intellectual freedom that still defines Latin American science and philosophy by promoting fresh perspectives and challenging conventional thinking.

Each of the three worldviews, Biblical, Ptolemaic, and Copernican, was influenced by significant individuals who presented and developed these ideas, which would later define the human understanding of the universe. Ancient cosmology, as described in the Bible, served as the foundation for the Biblical worldview, based on the notion that the universe was designed and controlled by a divine being. The authors of these works, who are frequently regarded as having been inspired by God, intended to emphasize God's position as the ultimate creator and authority rather than necessarily explain physical principles. By presenting a universe with an organized structure directed by God, these works provided answers for the origin of the world and the purpose of humans. Early theologians and intellectuals argued for the Bible's authority on issues of creation and existence which eventually strengthened this religious understanding of the universe. Since religious teachings were the main source of knowledge about the universe, the advocates of this worldview encountered minimal resistance inside their own religious communities. Rather, the difficulty was in maintaining and broadening this viewpoint as it was applied to other cultures, particularly when missionaries and institutions were being founded as was the case in Latin America under Spanish colonization. Alternatively, the Ptolemaic worldview developed directly from the work of Alexandrian astronomer Claudius Ptolemy in the

2nd century CE. Building on the geocentric theories of thinkers such as Aristotle, Ptolemy's study intended to develop a model that could precisely forecast the motions of celestial bodies. He collected information from his careful observations of the planets and stars, which he then incorporated into his highly influential work, the *Almagest*. Ptolemy created elaborate mathematical systems, such as epicycles, which are small circles the planets travel along as they orbit Earth to explain known astronomical movements with a geocentric foundation. By developing a cosmological model that fit the knowledge and beliefs of his era, he was able to explain known phenomena such as retrograde motion. Ptolemy was successful in developing this model because he was able to integrate mathematical calculations with actual observations to create a system that could accurately predict planetary movements. Because of its intricacy and compatibility with philosophical and religious views on Earth's fundamental role, the Ptolemaic model gained significant popularity, especially from the Catholic Church, which later approved it, as it followed biblical teachings. A thousand years after Ptolemy's time, the Copernican model introduced a radical change in astronomy. By proposing a heliocentric model that placed the sun, rather than Earth, at the center of the universe, Renaissance mathematician and astronomer Nicolaus Copernicus challenged the well-established Ptolemaic system. Copernicus was driven to simplify the complex Ptolemaic system and looked for a model that would be both elegant theoretically and in line with his observations. He proposed a worldview in which Earth and other planets orbited the Sun. Copernicus's concept was revolutionary since it went against both religious belief and the state of science at the time. Copernicus used mathematical reasoning and a thorough examination of planetary movements to support his claim that a sun-centered model could more precisely describe celestial movements than the

Ptolemaic theory despite lacking the telescopic instruments that Galileo would eventually build. Since his heliocentric theory went against religious beliefs that positioned the Earth and humans at the center of God's creation, Copernicus encountered strong opposition. Knowing that religious authorities would take issue with his work, he was hesitant to publish it. Only in his last years, with the support of close associates, did he agree to the publication of his research. His boldness in asserting that Earth was not the center of the universe called into question the fundamentals of both scientific and religious authority and initiated an extensive reconsideration of humanity's role in the universe as a whole. Additionally, each model's adoption, adaptation, or resistance was significantly influenced by the resources and instruments that were accessible in Latin America. Early colonization denied native astronomers the use of European astronomical tools, such as telescopes, quadrants, and astrolabes, which were necessary for accurate measurements and the confirmation of European cosmic theories. The colonial belief that European science was fundamentally superior was strengthened by this technological imbalance, which caused a power imbalance where European tools were seen as superior. But by the time the Copernican model began to take hold, intellectuals in Latin America, particularly in cities like Mexico City and Lima, had better access to scientific tools and techniques introduced by European explorers and scientists. In particular, Jesuit missionaries contributed to the spread of scientific tools and information, which occasionally put them at odds with Church leaders who were concerned that the Copernican model could conflict with the beliefs of the Church. By having access to these resources, Latin American researchers and scientists were able to make their own observations and gain a degree of scientific independence, developing an environment that was beneficial to the development of

innovative concepts. Astronomers like Galileo Galilei built upon and empirically supported Copernicus's heliocentric hypothesis, which later served as the foundation for further developments. Copernicus and his followers revolutionized the scientific understanding of the universe through careful examination and ground-breaking mathematical theories, igniting a new wave of inquiry that would influence the current scientific method. Each of these individuals made a distinctive contribution to cosmology, overcoming unusual obstacles and being motivated by various unique factors. The authors of the Bible sought to uphold humanity's unique position in a divinely organized universe and to offer spiritual direction. Motivated by his quest to forecast astronomical events, Ptolemy created a sophisticated model that combined philosophy, religious beliefs, and observations, bolstering a worldview in which Earth was unique and central. Copernicus laid the groundwork for scientific inquiry and the separation from religious beliefs by introducing a model that went beyond Earth-centered cosmology in his quest for simplicity and mathematical consistency. Each of these worldviews reshaped humanity's perception of its place in the universe, showing a path from divine interpretation to empirical observation and, ultimately, to a pursuit of mathematical harmony.

The adoption of each cosmological model in Latin America was shaped by different techniques that reflected the unique ways each worldview approached knowledge and truth. These approaches in turn affected people's perceptions of the universe and humanity's role in it. Each model, Biblical, Ptolemaic, and Copernican, relied on its frameworks for justification and explanation, which helped shape Latin America's changing intellectual culture. The approach of the biblical model was firmly based on religious texts' power and faith. In addition to bringing a new religion to Latin



America, Spanish missionaries and colonial officials also carried with them a particular worldview. This perspective believed that the Bible was the only trustworthy source of knowledge and that it held the answers to all questions concerning the universe, its existence, and the place of humans in the creation. The Bible offered missionaries an explanation of the universe that was authoritative and clear, emphasizing a divine, intentional design. It showed a world in which each planet, star, and terrestrial component had a specific role and cooperated under God's direction. Because of this idea, humans developed a worldview in which religious teachings and faith served as the foundation for their understanding of the world. By portraying the universe as an element of God's creation and highlighting humanity's essential and biblically ordered function, missionaries utilized the Bible and passages to explain natural phenomena and the beginnings of life. Because the Bible was the main source of information, it served as a crucial lens through which the universe was viewed, comprehended, and interpreted. Furthermore, by placing a strong focus on religious literature, faith was given priority over other theories or scientific observations. The biblical model of education left little chance for questioning or studying the universe outside of religious theology and instead emphasized the teaching of religious ideals and the reinforcement of biblical science. The Bible was regarded as both a religious document and a scientific authority in colonial schools that were overseen by religious institutions. This produced a worldview that profoundly impacted Latin American culture, permeating literature, art, education, and politics. The technique of the biblical model supported a spiritually significant universe in which knowledge was attained through commitment, faith, and devotion. The Ptolemaic model, on the other hand, offered a more methodical and observational approach to cosmology that was consistent with Catholic teaching and still permitted

real-world applications. The Ptolemaic model started to be taught more frequently as colonial Latin America's educational establishments grew, especially in metropolitan areas. Since it highlighted Earth's centrality and fit in with the religious belief that humans occupied a unique place in creation, the Catholic Church supported this geocentric concept. Colonial schools and universities, usually controlled by the Church, embraced Ptolemy's ideas and implemented a curriculum that taught celestial navigation, timekeeping, and fundamental astronomy using Ptolemaic concepts. The systematic approach of the Ptolemaic model aligned with the teachings of the Church since it maintained a view in which Earth and humanity held a special place in God's design. The Ptolemaic model included observational techniques that improved the understanding of the universe's structure, in contrast to the biblical model, which was mostly based on scripture. The Ptolemaic model established a natural philosophy that allowed methodical observation while remaining faithful to the teachings of religion. Observing celestial bodies, understanding their motions, and applying these insights to real-world tasks like timekeeping and navigation were all taught to the students. This made the Ptolemaic model useful in everyday life as well as religious contexts because colonial populations relied on marine transit and trade, both of which required precise navigation. This approach gave colonial civilization useful abilities based on Church-approved science by enabling people to track seasons, anticipate planetary movements, and navigate seas. The Copernican model began to make its way into Latin American intellectual environments, creating a significant change that occurred in both cosmology and methodology. The methodology was founded on systematic testing, close observation, and a readiness to challenge the norms. The Copernican model promoted independent research and empirical data as the foundation for comprehending the

universe, in contrast to the biblical and Ptolemaic models, which had depended on religious documents or structures approved by the Church. Latin American intellectuals who were influenced by the Enlightenment and new scientific theories from Europe started experimenting with the scientific method, testing and improving their theories of the universe through reasoning and observation. This change in approach was significant because it moved away from depending on religious authority and toward an evidence-based and experimental approach. With its focus on heliocentrism, the Copernican model offered an alternative to the Church's geocentric beliefs that called for evidence rather than faith. Because of this, scientific societies were created where intellectuals and academics could debate the ramifications of a world in which Earth was not at the center, often leading to arguments over heliocentrism. Despite frequently drawing inspiration from European models, these cultures developed unique Latin American traits that showed a growing desire for intellectual independence. Thinkers in these societies discussed the larger effects of scientific research in addition to astronomy. A critical mindset that challenged conventional wisdom and supported evidence-based knowledge was encouraged by the Copernican model. This change had an impact on a larger audience and promoted a culture of scientific exploration outside of the academic community. The Copernican method established the foundation for a skeptical and scientifically interested Latin American society. The Copernican model encouraged intellectuals to seek independent approaches to science and knowledge by questioning the geocentric model and the legitimacy of a religious worldview. It inspired educational institutions in Latin America to challenge traditional thinking, consider empirical data, and formulate concepts based on observation rather than belief. This shift was a pivotal moment in Latin American thought because it gave rise

to fresh perspectives on the universe that would develop over the centuries that followed.

Modern Latin American philosophy continues to be influenced by the Biblical, Ptolemaic, and Copernican worldviews, which have shaped the region's approach to balancing its cultural, religious, and scientific traditions. Even though science has come a long way since Copernicus' time, remnants of these earlier concepts are still ingrained in Latin American culture. For example, the Biblical worldview continues to have an impact on religious groups and educational institutions where moral instruction and spirituality are important, demonstrating constant respect for both scientific knowledge and supernatural answers. The Ptolemaic model's focus on methodical observation and conformity to religious doctrine is also evident in Latin America's longstanding reverence for science as a pragmatic and philosophical endeavor, where the universe is perceived as a place full of cultural significance in addition to being represented by mathematical models. From astronomical research to scientific organizations that encourage curiosity and creativity, Latin America has made significant contributions to world science that demonstrate the Copernican model's legacy. These historical models have been woven into a distinct scientific identity that recognizes both legacy and development, as Latin American societies show by adopting a self-sufficient approach to knowledge, one that respects tradition yet values evidence. This blending of cosmological viewpoints, blending the religious past with a scientific embracing of the future, has produced a layered approach to understanding humanity's place in the universe. From the colonial era until the age of scientific investigation, the Copernican, Ptolemaic, and Biblical models all profoundly influenced Latin American thought, changing cosmological and scientific viewpoints. In the early colonial mindset, the

biblical model offered a spiritually based framework that combined faith and astronomy. By bringing the region's worldview into line with that of Europe under the influence of the Catholic Church, the Ptolemaic model strengthened this belief through real-world and educational applications. Last but not least, the Copernican model brought a culture of inquiry and skepticism that complemented Latin American ideas of freedom and identity while also advancing scientific understanding. By bridging native viewpoints with European concepts, these models collectively created a distinctive legacy that has characterized Latin American contributions to science and culture, emphasizing the journey from religious devotion to actual scientific exploration.