Foundations of Heliocentrism: Aryabhatta, Copernicus, Kepler and Newton Mathematical

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Abstract— **This paper examines the evolution of heliocentric thought with a focus on Aryabhatta's pioneering contributions from India alongside the revolutionary works of Copernicus, Kepler, and Newton. Building on earlier analyses, we integrate discussions from Horace Shipp's 1944 book *Ideas That Moved the World*, which contextualizes Copernicus and Kepler within the broader intellectual transformations of human history. The paper argues that Aryabhatta's insights on planetary motion prefigured many later developments and highlight the global, rather than Eurocentric, nature of scientific progress.**

Index Terms— **Foundations of Heliocentrism, Aryabhatta, Copernicus, Kepler, Newton Mathematical**

I. Introduction and Literature Survey

The history of heliocentrism has often been narrated primarily through European figures such as Copernicus, Kepler, and Newton. However, Aryabhatta, the 5th-century Indian mathematician and astronomer, presented insights that anticipated many of these later developments. In his Aryabhatiya, Aryabhatta described a rotating Earth and provided rules of planetary motion without relying on epicycles. His framework shares striking parallels with the later advances in Europe.

Copernicus, in his seminal work *De revolutionibus orbium coelestium* (1543), shifted the astronomical paradigm from a geocentric to a heliocentric worldview. Johannes Kepler refined this with his three laws of planetary motion, introducing elliptical orbits. Newton's *Principia Mathematica* (1687) later provided the universal law of gravitation, which mathematically grounded the motions of celestial bodies.

Horace Shipp's *Ideas That Moved the World* (1944) provides a mid-20th century intellectual reflection on how such revolutions in thought — particularly Copernicus's heliocentrism — fundamentally altered human understanding. Shipp situates Copernicus alongside other world-changing thinkers, illustrating the intellectual courage required to challenge established traditions.

An important dimension of heliocentric analysis involves the question of planetary orbits. Aryabhatta's assertion of circular or nearly circular planetary paths has profound relevance when contrasted with both modern data and present-day pedagogy. NASA's tabulated orbital data confirm that Earth's orbit is nearly circular, with very small eccentricity. This matches Aryabhatta's original claim and directly contradicts the exaggerated elliptical depictions still found in modern geography and science textbooks. Such distorted illustrations mislead students into imagining Earth's orbit as highly elongated when in reality the deviation from a circle is minimal.

Thus, Aryabhatta's law of circular orbits is not only of historical interest but continues to carry scientific validity in the present day. Correct representation of these orbits in textbooks would both enhance scientific accuracy and restore recognition to Aryabhatta's contribution. Highlighting this issue provides a bridge between ancient Indian astronomy and present-day scientific communication.

II. Analysis of Results

In analyzing Aryabhatta's claim of circular orbits, it is essential to compare with modern observational data. NASA's measurements of orbital eccentricities demonstrate that Earth's orbit has an eccentricity of only 0.0167, which is so close to zero that the orbit is virtually indistinguishable from a circle. Other planets such as Venus ($e=0.0068$) and Neptune ($e=0.0113$) also reinforce the dominance of near-circular orbits in our solar system.

However, geography and science textbooks frequently present Earth's orbit as an elongated ellipse. These diagrams, while mathematically based on Kepler's first law, are not drawn to scale and give students the false impression that Earth's distance from the Sun varies drastically. This creates conceptual confusion and diminishes the accuracy of modern education. Aryabhatta's insistence on circular orbits, far from being outdated, aligns closely with the empirical reality for Earth and several other planets (refer to Table 1 and Figure 1) . Correcting these textbook illustrations would simultaneously improve scientific accuracy and highlight Aryabhatta's continuing relevance.

III. Discussion

A comparative reading reveals both continuity and divergence in these contributions. Aryabhatta, unlike the Ptolemaic astronomers, avoided epicyclic constructions and directly proposed that the apparent westward motion of the heavens was due to Earth's rotation. This anticipates Copernicus's heliocentrism by nearly a millennium. Kepler's recognition of elliptical orbits and Newton's dynamical law provided greater mathematical precision.

In *Ideas That Moved the World*, Shipp emphasizes Copernicus's paradigm shift as a hallmark of intellectual history. He presents Copernicus as not only a scientist but also a symbol of the human spirit's drive to break free from dogma. Integrating Shipp's reflections enriches the historical narrative by highlighting how Copernicus and Kepler were remembered in modern accounts as figures who moved the world's intellectual axis. Including Aryabhatta in

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this continuum underscores the global dimensions of the heliocentric revolution.

IV. CONCLUSIONS

The development of heliocentric astronomy cannot be reduced to a single region or tradition. Aryabhatta's mathematical astronomy provided early principles that resonate with Kepler's later laws. Copernicus's heliocentric theory, Kepler's refinements, and Newton's gravitational synthesis together represent milestones in scientific history. By situating these within the broader cultural reflections such as Shipp's *Ideas That Moved the World*, we recognize that intellectual revolutions are both global and cumulative in nature.

Furthermore, Aryabhatta's law of circular orbits remains directly relevant today. NASA's data affirm that Earth's orbit is nearly circular, making his framework scientifically sound even by modern standards. The frequent misrepresentation of Earth's orbit as a highly elongated ellipse in textbooks underscores the need to reintegrate Aryabhatta's insights into both scientific literature and educational materials. Correcting this misconception would improve accuracy and ensure that Aryabhatta's pioneering contribution receives the recognition it deserves.

V. REFERENCES

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Table 1: NASA orbital data showing semi-major axes and eccentricities of planets. Earth's eccentricity of 0.0167 confirms that its orbit is nearly circular.

Planet	Semi-Major Axis (AU)	Eccentricity
Mercury	0.39	0.2056
Venus	0.72	0.0068
Earth	1.00	0.0167
Mars	1.52	0.0934
Jupiter	5.20	0.0489
Saturn	9.58	0.0565
Uranus	19.22	0.0457
Neptune	30.05	0.0113

Figure 1: Comparison of Earth's actual orbit (nearly circular, e=0.0167) with an exaggerated textbook-style ellipse (e=0.5). The exaggerated diagram is misleading, whereas Aryabhatta's assertion of circular orbits better matches NASA's observational data.