International Journal of Engineering and Applied Sciences (IJEAS)
ISSN: 2394-3661, Volume-12, Issue-6, June 2025

Mathematical Foundations of Heliocentrism First at Patna India: Aryabhatta's Early Laws and the Historical Struggle Against the Ptolemaic System

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Abstract— **While the heliocentric model is commonly attributed to Copernicus and formalized by Kepler and Galileo in Renaissance Europe, evidence suggests that Aryabhatta I, an Indian astronomer of the 5th century, had already formulated planetary laws that mathematically require a heliocentric arrangement. This paper discusses Aryabhatta's three laws in the context of planetary motion, demonstrates their logical requirement for heliocentrism, and contrasts this with the struggles European scientists faced when proposing similar ideas in defiance of Ptolemaic orthodoxy upheld by the Church.**

Index Terms— Aryabhatta's, heliocentric model, European scientists.

I. Introduction: Scientific Dissent in Europe

Figs 1 shows orbits of planets which move along either along a circular or elliptical orbits. From the 2nd century CE, Ptolemy's geocentric model reigned in Europe, blending Aristotelian cosmology with ecclesiastical doctrine. Scripture was often interpreted literally, placing Earth immovably at the center of God's creation. In this environment, early heliocentric ideas were met with resistance [1-8]:

- Nicolaus Copernicus delayed publishing De revolutionibus (1543), fearing backlash.

- Giordano Bruno, who proposed an infinite universe with numerous worlds, was executed in 1600.

- Galileo Galilei was tried by the Inquisition in 1633 for advocating heliocentrism, spending his final years under house arrest.

- Johannes Kepler, though Protestant and free from the Inquisition's reach, struggled to disseminate his ideas amidst political and religious conflict.

These scientists endured immense personal risk to challenge entrenched belief systems with rational models based on observation and mathematics.

II. Aryabhatta's Theoretical Framework

Aryabhatta I (476–550 CE), writing in Aryabhatiya, postulated three key laws regarding planetary motion[9,10]:

1. Circular Orbits: All planets move along circular paths.
2. Constant Orbital Speed: All planets move at the same speed, but those closer to the central body appear faster because their orbits are smaller.
3. Earth's Rotation: The westward motion of stars is due to Earth rotating on its axis.

These laws anticipate concepts foundational to heliocentrism. Remarkably, Aryabhatta's assumptions simplify into a model consistent with Kepler's third law under circular motion approximation.

III. Proof of Heliocentricity from Aryabhatta's Laws

We focus on Aryabhatta's second law—equal speed for all planets—paired with his first law of circular orbits.
Let:

- r be the radius of a planet's orbit,
- T be its orbital period,
- v be the orbital speed (assumed constant across planets),

For circular orbits: $v = 2\pi r / T$
Since v is constant across planets: $r / T = \text{constant} \Rightarrow r \propto T$
Thus, if a planet has a longer period, it must be at a greater distance from the center of motion.
From modern astronomical data:

Table 1: Orbital Periods of Planets

Planet	Orbital Period (T, years)
Mercury	0.24
Venus	0.62
Earth	1.00
Mars	1.88
Jupiter	11.86

Since Earth's period exceeds that of Mercury and Venus, it cannot be at the center. Hence, Earth is not the center of motion—the Sun is. This mathematical deduction aligns

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with the structure of a heliocentric model and would have been incompatible with a geocentric system.

IV. Conclusion

1. In this work, at first, the history of astronomy of the solar planetary system was looked at. It was seen that the Greek planetary studies were most influential and were followed over a long time starting from Ptolemy (second century AD) to 16th century. It was followed by and large by Greek, and Islamic astronomers. The church in Europe followed this astronomy.

2. Aryabhatta did not follow Ptolemy and he came up with his planetary laws of motion but these laws remained in obscurity.

3. The results show that Aryabhatta's model is better.

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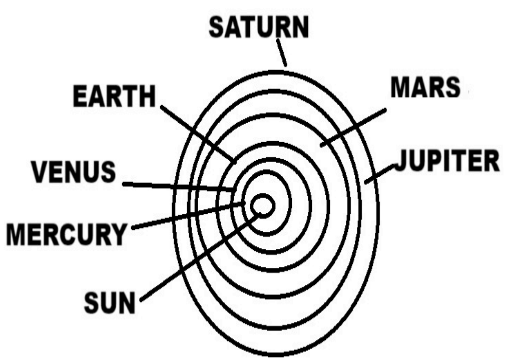

FIG 1 SUN AND THE PLANETARY SYSTEM