

Hipparchus and quantitative astronomy

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Core question

How did precise cataloguing, numerical parameters and comparison across generations make the changing sky measurable?

Historical and evolutionary context

Hipparchus, active in the second century BCE, belongs to a period in which Greek astronomy increasingly combined geometrical models with numerical observations. Only one of his works survives directly in full, the commentary on Aratus and Eudoxus, while much else is reconstructed from fragments and later authors, especially Ptolemy.

He is associated with quantitative work on solar and lunar theory, eclipse calculation, star positions and the discovery of precession. Multispectral imaging of the Codex Climaci Rescriptus has strengthened the evidence that numerical star cataloguing linked to Hipparchus existed, while also showing how fragmentary the surviving record is. The recovered coordinate material is direct evidence for a catalogue tradition rather than a reason to treat every later Ptolemaic value as Hipparchan.

What could communities know before this transition?

Astronomers could describe constellations, cycles and geometric schemes. Babylonian scholars had developed long numerical records and predictive arithmetic. The challenge was integrating positional observation, geometry and comparison through time in a systematic Greek astronomical framework.

What changed?

Stars and celestial motions became increasingly tied to numerical coordinates and parameters. Comparing observed stellar positions with earlier data allowed very slow change, precession, to become detectable. Knowledge could now emerge from differences between records made generations apart.

Why could this capability emerge?

It required observational instruments, geometric methods, inherited records and numerical techniques. Babylonian influence on Hellenistic astronomy is well established in broad terms, but individual transmission pathways should not be invented where evidence is incomplete.

What later forms of knowledge did it enable?

Ptolemy drew heavily on Hipparchan observations and methods. More broadly, the practice of cataloguing positions created a reusable quantitative sky against which later observations could be compared.

New limits and risks

Precision in a catalogue is limited by instruments, coordinate definitions and copying. Later texts can preserve earlier numbers while obscuring how they were obtained. Attribution is therefore partly reconstructive.

What changed in the architecture of human knowledge?

Observation became **intergenerationally comparative**. A dataset made in one era could reveal phenomena too slow for one observer to notice.

Loss, exclusion and uncertainty

The surviving evidence does not justify treating every later Ptolemaic parameter as simply Hipparchan. Recent recovery of catalogue fragments improves the picture but also exposes how much remains missing.

Dependency map

- INDIRECT ← PIO-018 Babylonian mathematical astronomy and sexagesimal place value
- DIRECT ← PIO-023 Deductive proof: what Greek geometers added

- INDIRECT ← PIO-026 Eratosthenes and the size of Earth
- DIRECT → PIO-028 Ptolemy and predictive mathematical astronomy

References

1. Schirroni, F. Hipparchus' Star Catalogues. *Archive for History of Exact Sciences* 79, article 11 (2025). <https://doi.org/10.1007/s00407-025-00346-8>
2. Glover, E. *The Astronomy of Hipparchus: An Annotated Translation of and Introduction to the Commentary on the Phenomena of Aratus and Eudoxus*. Cambridge University Press (2026). <https://doi.org/10.1017/9781009607544>
3. Gysembergh, V., Williams, P. J. & Zingg, E. New evidence for Hipparchus' Star Catalogue revealed by multispectral imaging. *Journal for the History of Astronomy* 53, 383–393 (2022). <https://doi.org/10.1177/00218286221128289>