Biographical Encyclopedia of Astronomers

Proclus

Born Byzantium (Istanbul, Turkey), circa 411

Died Athens, (Greece), 17 April 485

Head of the Athens Academy in the 5th century, Proclus promoted astronomy in mathematics, cosmology, physics; in empirical observation and instrumentation; and in higher education, proposing that celestial objects have their own self-movement in free space, that our system can be heliocentric, and that cosmic space consists of pure light. He was the last major thinker of Antiquity, and also the one who systematized Greek knowledge in the form it was transmitted to Islam and western Europe.

Proclus' Greek-speaking parents, Patricius and Marcella, moved from Byzantium to Xanthus, a district of Lycia in Asia Minor, probably by 415. Proclus studied rhetoric, Roman law, and Latin at Alexandria He visited Byzantium during the revival of advanced schools inspired by the Athenian-born Empress Eudocia (425). There he experienced a momentous conversion to Athenian philosophy. On his return to Alexandria, Proclus studied Aristotle and mathematics, which included astronomy. He then traveled to Athens (430), where he was quickly embraced by the leaders of the Neoplatonic academy and studied the philosophy of Aristotle, Plato, and other Greek thinkers. Proclus rose to become head of the premier center of higher learning in the Roman Empire at the age of 25. Around 450, he traveled for a year's sabbatical to the region of Lydia in Asia Minor to avoid persecution by the Christian authorities. His chief surviving book on astronomy was written just after this trip. In Athens, Proclus pursued a career as a teacher, author, administrator, and influential figure within the empire, which left his followers in awe, as recorded by his biographer, Marinus. The biography concludes with a valuable reference to two solar eclipses at Athens, one precisely observed (January 14, 484) and one predicted (May 19, 486).

Proclus' integration of astronomy and physics with his metaphysics freed scientific thinking from constraints owed to Aristotle and Ptolemy. But he was not just a theoretician. He promoted practical and empirical knowledge, for they combine critical reasoning with direct perception of the appearances of reality. Proclus' chief astronomical treatise, the outline (*Hypotyposis*) *of the Astronomical Hypotheses*, contains a detailed description of how to construct and calibrate the spherical armillary astrolabe, and how to make observational measurements of the Moon and the stars; he noted the existence of optical binary stars. He also refers to the use of Heron's water clock to measure the Sun's diameter, to the meteoroscope instrument, and to the actual construction of ephemerides tables. He made some of the last reliable astronomical observations of Antiquity (475).

Proclus' views on astronomy are part of his responses to the core questions: How much can the appearances of things tell us about their deep nature? What is the nature of reality? For Proclus, celestial objects are "self-substantiated" agents with the power to move freely of

their own accord. They orbit according to their own natural, unimpeded motion and move in the three dimensions of free space without the need for celestial spheres. Proclus further proposed that every fixed star and planet must have its own spin around its axis. He went so far as to suggest that the Earth itself is like a star, and if it were not for the inertness characteristic of its predominant physical property, it should move circularly.

Proclus advanced the heliocentric view. He accepted that the celestial bodies revolve around the Earth as center but only in their capacity as Earth-like bodies. Since it is their self-power that really matters, they should be arranged around the center of most power: the Sun. The Sun is also in the middle of a system consisting of the five observed planets, the Moon, and the Earth's four elements. Furthermore, Proclus speculated that every planet has its own group of attending "satellites."

Proclus poured scorn on astronomers such as Ptolemy, who believed that inventing epicyclic and eccentric spheres could explain away the apparent irregular movement of the planets, the Sun, and the Moon. Proclus took these irregularities seriously, as problems challenging us to reconcile our current level of understanding with that proper to deeper reality. He also rejected Hipparchus' discovery of the "precession," as described by Ptolemy, and Ptolemy's interpretation that the precession involves a backward movement of all the stars. For Proclus, the stars are fixed in their constellations and do not precess. Proclus' *Outline of the Astronomical Hypotheses* contained the only critical evaluation of Ptolemy in antiquity and rejected his speculations on many counts.

Proclus also rejected Aristotle's fifth element for the heavens. For Proclus, the heavens have the same four constituents (fire, air, water, and earth) as the Earth, but in a different state of matter. This contains the "summits" of all the elements, where the properties of fire prevail. He concluded that the celestial bodies must also have some Earth properties, to be opaque (as in eclipses) and have gravity. Above all, he asserted that there is one science for both the heavens and Earth, not separate ones.

In cosmology, Proclus was the first to propose that space must be a three-dimensional body of a special kind that allows normal bodies to coexist with it. He speculated that there is a cosmic space, a body of pure, invisible light, in which the entire Universe is immersed

Proclus instilled astronomical interest in his students, including Marinus, his successor at the Athenian School; Ammonius; and Ammonius' brother Heliodorus. The latter records Proclus' observation of an occultation of Venus by the Moon (475) from Athens. Ammonius' students Simplicius and the Christian John Philoponus wrote the major commentaries on Aristotle, but followed Proclus in the rejection of Aristotelian physics and accepted most of his views on the celestial bodies and the elements

Through the Byzantine emigrants Gemistos Plethon and John Bessarion, Proclus and Ptolemy spread to Renaissance Europe. By the 16th to 17th centuries, Proclus' mathematical and astronomical achievements gained wide recognition. Proclus' *Commentary on Euclid* was highly regarded and discussed in Galileo Galilei's circle. Nicolaus Copernicus cited it in the *Revolutions of the Heavenly Spheres*, and Johannes Kepler did likewise in the *Harmonices*

Mundi (1619). Kepler quoted Proclus repeatedly and praised him as a true precursor of the heliocentric theory.

Proclus' name has been given to a lunar crater near the Sea of Tranquillity.

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