

Biographical Encyclopedia of Astronomers

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Democritus of Abdera

Born Abdera (Ávdhira, Greece), circa 460 BCE

Died (Greece), circa 370 BCE

Democritus's intellectual interests spanned an enormous range, from the mathematical and physical nature of things to the ethical and social sphere.

Tradition holds that Democritus was born in the 80th Olympiad (460-457 BCE) and lived to at least 90 years. Many sources give 460-370 BCE for his life span. It is reported that Leucippus, his teacher, was old when Democritus was at his height, and he himself tells us that he was a young man in Anaxagoras' old age, being 40 years his junior. Democritus was also a contemporary of Socrates

Democritus was born into a wealthy family and chose to use his rather substantial inheritance to travel, study, and learn as much as possible. He traveled over much of the known world, including Egypt, Persia, Babylon, and possibly even India. Everywhere he went, Democritus sought out men of learning and studied under their direction. According to Diogenes Laertius, as a young man, Democritus visited Athens to see Anaxagoras. When Democritus had spent his wealth, he returned to Abdera and started a school, which lasted beyond his lifetime.

Democritus is credited by Diogenes Laertius with having written 73 works (other writers say fewer) on an incredibly wide range of subjects, from the nature of matter (for which he is most famous) to ethics, psychology, mathematics, astronomy, and medicine. It is unfortunate that none of these extensive works survive, and only titles and fragments handed down by others are known. We have some insight into his thought through the fragments of his texts preserved in the writings of later authors, among them Diogenes Laertius, Theophrastus, Aetius, Plato, Aristotle, Epicurus, and Lucretius.

Leucippus is often cited as the father of the atomic theory, but it is clear that others, perhaps even the Pythagoreans, conceived of the material world being composed of individual particles. In any case, Democritus developed the atomic theory in a rather complete and consistent fashion, explaining the origin and operation of the world and elaborating Leucippus' more primitive statements. The crux of the atomic theory, as expounded by Democritus, is that the world is made up of "[the] full and the empty," i.e. Atoms are indivisible particles that are constantly in motion and occupy empty space. Changes in shape and condition, the formation of things, and their disintegration result from the continuous aggregation and separation of atoms. The atoms themselves do not change; they are indivisible. (The word atom comes from a Greek word meaning "uncuttable.") The atomic theory as proposed by Leucippus and Democritus was a deterministic theory that eliminated the need to introduce the "gods" to explain physical phenomena.

The atomic theory as conceived by these philosophers provides a basis for a self-consistent cosmology, in which the facts of observation played an important role. In many ways, Democritus' astronomy mirrors some features of Anaxagoras', but without much in the way of theoretical innovation. The fact that theory did not improve is surprising, since Democritus appears to have been a rather remarkable mathematician. Diogenes Laertius lists five mathematical texts attributed to Democritus: one on the contact of a circle and a sphere, two on geometry, one on numbers, and one on irrationals.

D. R. Dicks lists a number of titles attributed to Democritus that concern astronomical topics. Among these are writings *On the Planets*, *The Great Year or the Astronomy*, and *The Calendar*. The astronomical ideas of Democritus included the notion that there are multiple worlds of differing size, stage of development, and support of living creatures. Furthermore, he said that the stars are (fiery) stones, and the Sun is a luminous red-hot stone or a stone on fire, and of very great size. The Moon has plains, valleys, and mountains that cast shadows. According to Plutarch, he seemed to accept the notion that the Moon is luminous due to reflected light from the Sun. The Earth is disk-like but somewhat hollow or concave, contrary to Anaxagoras's flat disk. Democritus, following Parmenides, thought that the Earth was in a state of stationary equilibrium. Many Greeks at the time supposed that the Earth was circular with Delphi at its center, but Democritus, according to Agathemerus, recognized that the Earth was oblong with its length being one and a half times its width. (It is not clear how to reconcile this statement with the previous description of the shape of the Earth.) Democritus, along with Eudoxus, is credited with creating a map of the Earth based on geographical and nautical surveys, in the manner of Anaximander and Hecataeus of Miletus. He agreed with Anaxagoras that the Milky Way consisted of a multitude of very close stars whose light blurs together to form a rather continuous distribution. Comets were conjunctions of planets or stars that come close together so that their

Light blurs to form an elongated object. According to Aetius, Democritus arranged the celestial bodies, starting from the Earth, in the order Moon, Venus, the Sun, next the other planets, and finally the fixed stars. Seneca reported that Democritus held that the planets were at different distances from the Earth and that there might be stars that have motions of their own. Vitruvius ascribed a catalog of stars to Democritus, and Censorinus said that Democritus put the Great Year at 82 years with 28 intercalary months. (This, however, appears to be an error because 28 intercalary months would correspond to 76 years.) According to Otto Neugebauer, Democritus gave the intervals between equinoxes and solstices to be 91, 91, 91, and 92 days, with the last being the number of days between the vernal equinox and the summer solstice, assuming 365 days as the length of the year

Democritus attempted to demystify natural phenomena, expounding a deterministic rationale for the operation of the world based on a complex system of eternal atoms in constant motion. His works were contested and yet admired by giants of the ancient world such as Aristotle and Archimedes. The fact that only fragments of Democritus's many works survive is a great loss to our understanding of the evolution of ancient Greek philosophical thought.

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