Biographical Encyclopedia of Astronomers

Pythagoras

Born Samos, (Greece), circa 570 BCE

Died Metapontum or Croton (Crotone, Calabria, Italy), circa 480 BCE

Pythagoras was a curious combination of a charismatic guru and mathematical genius, who founded an influential movement characterized by belief in reincarnation, moral and religious purity, and a predilection for numerical explanation. The Pythagorean doctrine that the nature of things consists in mathematical structure led both to Plato's theory of forms and to Greek astronomers' lasting preference for simple, constant motion

Born the son of Mnesarchus, a gem engraver, the young Pythagoras traveled widely for many years, acquiring both scientific information and religious lore. He is reported to have heard Thales and Anaximander and to have studied with Egyptian priests and with the Chaldeans. These undoubtedly encouraged his mathematical and astronomical interests. On the religious side, Pythagoras, associated with Zoroasterism or the Magi, was initiated into numerous mysteries and went into the cave on Mount Ida with Epimenides, a famous Cretan miracle worker. Heraclitus, a champion of the Empirical search for natural regularities and despiser of omnivorous polymath, accused Pythagoras of patching together an idiosyncratic pseudo-wisdom from these eclectic sources.

Returning to Samos when he was about 40 and finding the rule of the tyrant Polycrates disagreeable, Pythagoras immigrated to Croton. An eloquent speaker, he quickly achieved prominence, preaching virtue, self-control, and a simple lifestyle to various audiences, including—contrary to custom—married women apart from their husbands and boys apart from their parents. He established a quasi-religious, quasi-philosophical organization, under whose leadership the city prospered so conspicuously that Pythagoreans rose to power in several neighboring cities Pythagoreans were divided into a larger body of *acusmatici* (hearers) and a smaller inner circle of *mathematici* (learners) who adopted a moderately ascetic life characterized by mathematical and astronomical research, secret doctrines, abstinence from animal food, communal living, and various purificatory rituals connected with belief in reincarnation. Around 500 BCE, Kylon, a rejected applicant to the order, led a coup in which many prominent Pythagoreans were assassinated. Pythagoras escaped, finding refuge in Metapontum. He is variously said to have lived to the age of 80, 90, or 100, and may have returned to Croton.

Although Diogenes disputed it, most likely Pythagoras, like Socrates and Jesus, wrote nothing. Because Pythagoreans kept their more innovative doctrines secret and honorably attributed later discoveries to the founder, identifying a doctrine as Pythagoras's own is highly conjectural. Clearly, he instituted a way of life based on a core of distinctive cosmological and anthropological beliefs. Pythagoras is reported to have been the first to call the Universe *kosmos* (although Anaximander certainly used the term), meaning that it is an ordered whole.

The Universe is not mindless matter but a living god, breathing in the surrounding emptiness. Human souls are alienated portions of the divine world-soul, immortal but repetitively embodied in various forms, including nonhuman species. Pythagoras taught the kinship of all life; accordingly, he regarded the animal sacrifices pervasive in Greek religion as par-ricidal. Pythagoreans even avoided eating anything that seemed to contain soul, such as fava beans.

Pythagoras, using the monochord, discovered that the musical scale instantiated certain whole-number ratios: the octave (2:1), the fifth (3:2), and the fourth (4:3). Because the integers in these ratios add up to ten, ten was regarded as the perfect number and the key to all mathematical truth. He evidently generalized the idea that music consists of numbers to everything else. (Aristotle wrote that the Pythagoreans claimed that all things—perceptible objects, souls, and even moral qualities—are numbers.) There are two fundamental principles: limit and unlimited. The cosmos and its contents are products of the imposition of limit on the unlimited, various kinds of things being distinguished by different numerical formulas. Various qualities, including moral virtues, are just special types of mathematical harmony. Living an orderly, non-violent, scholarly life insures better rebirths and eventual reunion with the cosmic soul. Pythagoras called this manner of living "philosophy" and himself a "philosopher," originating a sense of those terms subsequently adopted by Plato. Pythagoreans allegedly suppressed the proof that the hypotenuse of a right triangle whose other sides were numbers (i.e., integers) could not be a number, since this anomaly contradicted their thesis that all things, including spatial magnitudes, are numbers. Plato subsequently avoided the problem by constructing the cosmos from geometrical, rather than arithmetical, units.

In applying his seminal discovery to astronomy, Pythagoras imputed musical form, as well as mathematical order, to the heavens. The idea behind the doctrine of the "harmony of the spheres" seems to be that the movements of such huge objects must make sounds; And, as the pitch of a vibrating string varies with its length, the pitch of a celestial object varies with the radius of its orbit. Pythagoras may have assigned the same three ratios he identified for strings to the stars, the Sun, and the Moon. Later Pythagoreans assigned other musical ratios to each of the known planets. We do not hear this celestial music because it is omnipresent and invariant, and our auditory apparatus only detects vibratory change. Obviously, music is temporal, and time itself seems to be a serial order of events. For Pythagoreans, time consists in the repetitive orbits of the celestial bodies, themselves embodiments of harmonious numerical arrangements. In later antiquity, the "harmony of the spheres" was mostly a curiosity; but Pythagoras's belief that celestial bodies must move in a constant and mathematically elegant way, despite observational evidence to the contrary, continued to dominate astronomical theory. The centuries-long project of "saving the appearances" of planetary retrograde motion by hypothesizing uniformly rotating nested spheres (Eudoxus, Aristotle) or a combination of uniformly rotating deferents and epicycles (Apollonius, Hipparchus, Ptolemy, even Nicolaus Copernicus) testifies to the persistence of Pythagoras's preference for uniform motion.

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