

COSMOLOGY without HEADACHES

(Lecture Series)

(compiling, transcribing, researching, editing always in progress)

LECTURE V: Rise of Greece; Advent of Philosophy with the 'Pre-Socratics'

Greek history, as with all ancient civilizations, is only partially known. Historians have divided it variously. The easiest to understand is the one we will generally follow:

A. c.6,000 – 1400 B.C. The era of Crete

The Minoan civilization—so named after perhaps mythical King Minos [one might seek out the story of Theseus—son of Aegeus, king of Athens; the Labyrinth beneath the palace at Knossos; and the destruction of the Minotaur—a monster conceived in an affair between King Minos's wife and a divine bull sent by Poseidon]—was a bronze age culture. While Greece shows evidence of being populated as early as we find stone age remains anywhere in the world, the Cyclades were only occupied in approximately the 5th and possibly as far back as the 6th millennium B.C. These islands, at first, came generally under the dominance of Crete, whose true civilization flowered only about 2000 B.C. at Knossos. But these people may not have been what we consider Greek type. It is possible they were (as Herodotus claimed) Egyptians. While they borrowed obviously from Egypt, archeology has shown the character of their culture to be highly individual, less influenced by the Middle East than would be expected if they were actually Egyptian. They were highly influential on the Mycenaean civilization which followed. The ancient Cretan civilization was disrupted it has been thought by the eruption of the island of Thera, but recent scholarship suggests the dates do not match, and that, in any case, the great palace at Knossos was rebuilt after its destruction. Crete was perhaps weakened by its own prosperity and succumbed to the Mycenaeans. In any case, the great palace at Knossos was rebuilt.

B. 1650 to 1200 B.C. - The Era of Mycenae (or the Mycenaean culture)

These two—Crete and Mycenae—together are often referred to as the Heroic Age. Restrictions of written language almost completely to only economic dealings left us with no written records of either of these cultures. So, while art and architecture and something of the Minoan style of life, strongly colored by increasing ties to the Egypt of Amenhotep III (1420-1386 B.C.) and Amenhotep IV [*Ikhnaton*] (1385-1358 B.C.) through Tutankamen and into the 19th dynasty (to 1200 B.C.), especially due to the rise of the Phoenicians, had a lasting influence on later Greeks, there is nothing here relevant to our cosmological investigations. The Mycenaean decline is, however, approximately, coincident with the Trojan War (corresponding to the sixth or seventh level of Troy per Schliemann's excavations [1870s]) and the setting of Homer's *Iliad*; a time when Attica seems to have begun coalescing into a political entity.

C. 1200 - 900 B.C. - The Dark Age

About 1200 the whole ancient world seemed to go into a period of decline. This has been attributed for many years to an invasion by the mysterious 'Sea People.' This explanation has recently come to be seriously questioned. Although (according to the records of several civilizations) invasions did take place, this strange group called the Sea People has failed to materialize historically. Egypt declined, even though they successfully resisted the Sea People; the Hittites declined; cities all over the eastern

Mediterranean were destroyed (a striking percentage of them by fire) along with the Minoan and Mycenaean civilizations. Recent speculation has it that this razing of cities had to do with a dramatic change in the techniques of warfare, and that the large population movements may have been the result of such destruction rather than its cause. Some historians have ventured that the interdependency fostered by increasing trade, at first tending toward prosperity, may have resulted in a domino effect when certain of the major centers collapsed, causing the whole economic system to fail. Thus individual cities were weakened and perhaps decreased in population, making them more vulnerable to attack. This, however, does not sufficiently explain the simultaneous demise of the empires of western Asia. In any case, these 300 years are obscure and it seems civilization was temporarily lost to Greece.

D. 900 – 700 B.C. - **The Archaic (pre-classical) **Age****

Recovery here, as with the descent into darkness, was coincident with recovery of the rest of the Near East. The Assyrians emerged as the dominant power and, along with Egypt, exerted considerable influence over the redevelopment of Greece. Mediterranean trade flourished once again via the Phoenicians, and the Greeks (several of the competing and developing city-states, or *polies*, began a long period of colonization, westward along the southern coasts of Italy and what is now France, including Corsica and especially Sicily, as well as throughout the Aegean as far as the Black Sea.

E. 700 – 400 B.C. - **The Classical Age and the Rise of the City-States**

This, generally the ‘Pre-Socratic’ era, is what will be discussed in this session.

F. 400 – 200 B.C. - **The Hellenic Era**

The prominence of Athens; Plato and Aristotle carry philosophy to new heights; the rise of Macedonia under Philip II, the conquests of Alexander the Great; and the crumbling of his empire after his death, and:

G. 200 B.C. - **The Roman Era**

This age begins with Rome’s declaration of war against Philip V of Macedon and the subsequent expansion of the Roman Empire over the known world. (Periods *F* & *G* will be taken up in later sessions).

In ancient Greece, nearly a thousand years before the birth of Christ, a breeze began wafting across the mindscape. Something new was in the air, due in great part, many scholars now believe, to the coming together and reformulating of ideas from the orient—from India and China, as we shall see, as well as from Egypt and Babylon (or Chaldea, as the Greeks referred to it). At least this was a turning point, and a few faltering steps were taken in the general direction of modern understanding. It was not yet modern understanding, of course, nor did they proceed very far with it in the realm of what we now call physics. Little by little, however, as men looked heavenward, they began to see ‘things’ proceeding across the sky; items that, however little understood, were not gods, not living beings but physical objects, which means they were logically explicable natural events. Astrology was essentially unaffected by this change but astronomy, rightly (even if as yet poorly) understood, was thus born.

It was debated whether the stars were holes in the sky, or points of fire, or some sort of gems or shiny ‘nail-heads’ attached to the outermost sphere reflecting the light of

the ‘central fire.’ In any case, they gradually lost their divinity, and the planets were seen as inanimate discs, or bowls, or holes exposing a universal fire, or even globes by some, that moved independently. Ideas of a structured physical universe were conceived and advanced in letters and documents, a few scraps of which still survive—others lasted long enough so as to be translated into Latin and Middle-eastern languages by scholars of a much later period. Some of these fragments hint at a high degree of originality and even conceptual genius on the part of their inventors.

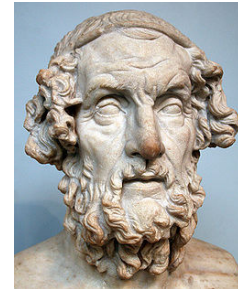


Thales of Miletus [-6th century]

is considered by many to be the first philosopher, though there is a school of thought that sees the much earlier

Homer [-8th century]

as revealing some of these evolving ideas, albeit poetically. The language of poets, however, tends to take the shape of concepts held by the reader or listener, and is especially prone to the temptation



of reading modern ideas back into ancient minds. We know precious little about Thales himself. If he wrote anything, it has been lost. His ideas were remembered through his pupils, associates, and in the works of his supporters and detractors. But we know almost nothing very certain about Homer, either. We do know the Greeks held him in high esteem, although by the period in which we shall begin our discussion, as a man, he was already lost in the mists of time. We have no records of his actual writing, and there is doubt he could write at all—even some doubt as to his existence. It has been argued that his well known stories of the Trojan War and the adventures of Ulysses were an oral tradition, not written down until much later. That means we may have something of the essence of Homer: the core of his poetic histories, but with vast possibilities for untraceable alterations, reinterpretations by reciters (e.g., the *Rhapsodes*) of differing backgrounds for their various audiences, and certainly a multitude of mistakes. (Proof of this exists in the laws that were passed by various city-states prohibiting reinterpretation and preferential editing of Homer’s works, which had become practically a sacred oral tradition; i.e., ‘proof’ that his tales had already undergone such ‘adjustments.’)

Whatever is the case in that regard, there are very few astronomical references in Homer’s work. Aside from the fact that we cannot even be sure they were his, there is no attempt in them at theory nor any speculation about the working of Universe that might lead to adjustments in Greek cosmic and philosophic perception as did the thoughts and teachings of the ‘first philosophers.’ Homer’s contribution was more the gathering together of a mythology and the presentation of a cultural background; cement for an emerging people, as with the *Nibelungenlied* for Nordic and Germanic peoples, the Vedas for India, the Old Testament for Jews, and the New Testament for Christendom. Those mentioned are considered among the very greatest of works because they laid a foundation for civilized morality durable enough to survive the inevitable erosion of religious faith—so that the structure of civilization might withstand not only the tempests of warfare and the pressure of disease and famine, but also the decadence associated with unabated prosperity, effete intellectualism, and socially corrosive atheism.

The Milesians

Thales is sometimes referred to as the ‘father of science.’ He is of particular importance in our cosmologic scheme, as he is the first Greek thinker to be associated with the advancement of knowledge of the natural world without leaning on myth and the intercession of gods. He and his two most famous products (Anaximander and Anaximenes) represent what is known as the Milesian school: the earliest attempt at a philosophical system—a *non-theistic explanation of the world*. Incidentally, that does not make Thales or his followers atheists. In fact Thales was a full-blown pantheist, seeing God (or gods) in everything. But he did not attribute the origin of being to Him (or them). His message was that a great store of knowledge can be found (beyond that handed down by tradition and through trust of authority) by observation, logic, and deduction – *the embryo of scientific method*.

More mathematician than astronomer or physicist, but generally (since, in the ancient world, all these things were subsumed under the canopy of philosophy) a philosopher, Thales was *foremost of the ‘seven sages’* of pre-socratic Greece [the others were *Solon of Athens; Chilon of Sparta; Bias of Priene; Cleobulus of Rhodes; Pittacus of Mitylene; and Periander, the 2nd tyrant of Corinth* (all approximately from about 650 to 550 B.C.)]. It is most likely that his mathematical foundation was formed in Babylon, for we know he traveled there, and recommended the same adventure to his followers.

The idea of reducing the multitude of substances to smaller and fewer elements was coming into vogue among Greek thinkers, possibly due to the mixture of sometimes conflicting ideas—especially religious influences from India, which may have begun diluting the sincerity of belief in what was essentially the Olympian version of the Egyptian pantheon. Thales’ version of reductionism, therefore, though certainly boosted by his fame and celebrity, may not be completely original with him.

For Thales, everything was based on (and could be, theoretically, one would suppose) reduced to one element: **water**—which, everyone could agree, was at least one of the primordial substances. Nietzsche remarked, in his *PHILOSOPHY IN THE TRAGIC AGE OF THE GREEKS* (§3) [*per WIKIPEDIA* (‘Thales’)],

Greek philosophy seems to begin with an absurd notion, with the proposition that *water* is the primal origin and the womb of all things. Is it really necessary for us to take serious notice of this proposition? It is, and for three reasons. First, because it tells us something about the primal origin of all things; second, because it does so in language devoid of image or fable, and finally, because contained in it, if only embryonically, is the thought, ‘all things are one’.

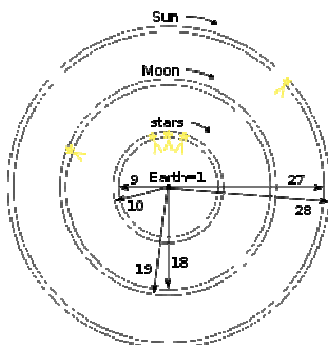
There were critics, of course. While it might be accepted that air was but evaporated water; that life may have begun in the aqueous realm; even that Earth itself (as for Thales) was a wide but thin cylinder, like an immense tambourine floating in water, it was more difficult to explain how fire might be water-based.

Obeisance to authority and ‘wisdom’ was ancient tradition, however, and Thales was held in high admiration for his mathematical skills and his knowledge of cosmic mechanics. His reputation was especially enhanced by his *prediction of the solar eclipse of 585 B.C.*, though it is now considered likely that (if he actually made such a prediction at all) he got this information from the ‘Chaldeans,’ who



heavily influenced his concepts, and who, as we have seen, had a system that was based not on theory but on charts made over centuries of observation, which exposed the regularity of certain cosmic events. He was also known for his theorem that only right triangles can be inscribed in a circle (no matter where one puts the apex), as long as the triangle's longest side is the diameter of that circle. He was the first to suggest a distinct difference-in-kind between the nature of the slowly rolling background of 'fixed' stars and the separately moving planets. Some of his ideas may seem relatively simple, if not obvious, to modern minds—and some of them were dead wrong—but in his thought we catch the leading edge of what came to be known as deductive science.

His best known pupil, **Anaximander** [-610-545], also a Milesian, refined some of Thales' ideas, and added his own. He was prone, already, to eliminate the gods altogether from material things and to derive natural explanations for all phenomena, describing such as Zeus's thunderbolts as compressed air building up inside clouds until the pressure caused the clouds to burst with a great flash, thus *founding the science of meteorology* (though it was not yet so named nor set apart. But like all the sciences we moderns have separated into 'disciplines,' to the ancients it remained undefined as part of general philosophy).



called a breathing hole through which the fire flamed forth, which corresponded to the visible sun, moon and planets.

For Anaximander, water was not the prime element; nor were any of the four basics (*air, water, earth, and fire*), as they all, in certain respects, had conflicting natures. For Thales, this conflict had seemed the basis of change in the universe, each element trying to dominate at the expense of the others—but, none being able to achieve hegemony, a balance between them was maintained. Unable to resolve the problem of how conflicting and especially directly opposing natures could transmogrify into one another, Anaximander concluded *there must be a substrata of sorts, which he called 'aperion'*, through which state the four elements were eternally intertransformed. The non-observable and unspecified nature of *aperion* made this idea no less difficult to defend than the water-based cosmos of Thales. Although the same objection could have been raised, of course, in connection with the gods themselves, that seemed not to be problematic for most ancient Greeks. But another Milenesian, **Anaximenes** [-6th century], would resort to *air as the prime element*, explaining the rainbow as sunlight shining through moist air; air on the verge of becoming water.

His Earth was at the center of *a universe consisting of several nested and separately turning wheels* (something like giant bicycle inner-tubes with their imaginary axes intersecting at the center of the Earth.). The space inside the tubes was filled with fire, and each 'wheel' had what might be

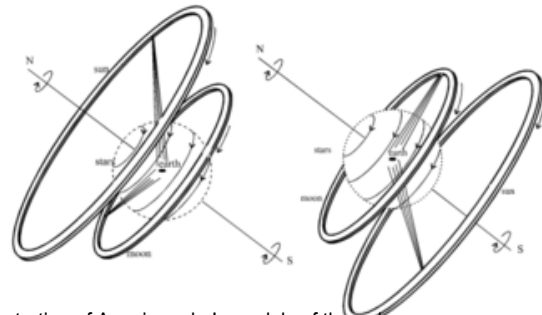


Illustration of Anaximander's models of the universe. On the left, daytime in summer; on the right, nighttime in winter.

Anaximander even felt the need to provide *a mechanistic cosmogony*. Eternal cycles of hot and cold eventually effected a sphere: a shell of fire around Earth. This sheath of fire gathered, due to its motion, into the various wheel-shaped rings. The outermost sphere, however, upon which are fixed the stars, perhaps due to its turning much more slowly, did not reshape itself. Beyond that sphere, however, Anaximander expected *aperion* to be infinite in extent: ‘the boundless,’ he called it (perhaps the prototype of the aether, which ‘existed’ even for many moderns until the early 20th century), making possible unknown worlds of unknown number beyond this one—an *infinite universe* (or as many moderns inexplicably say “other universes”; as if ‘universe’ could have a plural form). This was unique at the time, and remained so for many years. It must have seemed absurd to most Greeks, who otherwise did not consider what might lie beyond the stars—or else they considered that it was naught, and therefore not worth further consideration. This boundless formlessness, to Anaximander, was not ‘nothingness’ (impossible except in concept), but could be understood only as ‘chaos,’ or what we, today, might call potential. It is, in a way, *the first suggestion of the concept of energy*—a ‘something’ insubstantial yet, for moderns, useful and even quantifiable.



Dispensing with Anaximander’s wheels within wheels (could this have inspired Ezekiel?—they were contemporary), his younger friend or student **Anaximenes** suggested that the sun, moon, and planets were actually discs traveling across the canopy of fixed stars. Unlike that of Thales, the universe concepts of Anaximander and Anaximenes allowed the sun, moon, and stars to travel full circle around (beneath) the Earth. Earth itself, no longer floating on water, was equidistant from the rest of creation, thus forever in balance at the center—a jumping-off point for a theory of gravity. But we are also jumping to conclusions, for we do not

really know precisely what the Milesians had in mind in this regard. Anton Pannekoek [A HISTORY OF ASTRONOMY; George Allen & Unwin Ltd.; London, 1961] says “a creation out of nothingness was beyond their imagination.” I must say that it is still beyond my imagination, and one’s ability to accept it as fact seems more like dementia than intellectual progress. As for the Milesians, we can only be sure that they were the first known materialists to present their ideas systematically and non-theologically (possibly excepting the Yogic interpreters of the Indian Vedas).



The Pythagoreans

Pythagoras [of Samos, -570?-500?]

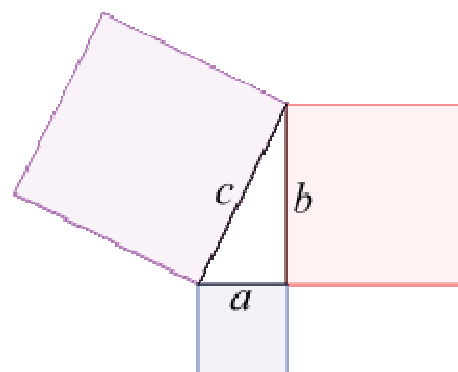
Like Thales, Pythagoras built on a foundation of older mathematics. He was obsessed with the idea of number. He thought of number as connected to the divine and came to see *the world as nothing but number*, or reducible to (or at least fully explainable by) number. Rather than turning away from metaphysics in his ideas, as was the tendency of the Milesians, Pythagoras intensified the mysterious and mystical. Despite his own apparent inclination toward free-thought, his ‘school’ became more like a cult and his followers more like acolytes. He founded a communistic society, in fact, with strange and rigid rules of behavior. While certain aspects may seem modern (e.g., equality of women and the holding of all property in common), it was mandatory to

follow the master's teachings in every detail, including the prohibition of any of its members taking credit publicly for their individual ideas. All concepts discovered by members of the sect were to be considered as having been discovered by the whole body of members—i.e., all their ideas were **'Pythagorean.'**

The master's influence was away from materialism as substantialism. He thought the real world could be and would be explained mathematically (as many modern mathematical abstractionists still believe), something like his explanation of music, as the continual interrelationship of sheer number. He is well remembered by musicologists as the discoverer of the *2:1 ratio of the octave and its natural subdivisions* in accordance with the various length-ratios of a vibrating string. This allowed the organization and categorizing and deepened the understanding of the several modes in Greek music and provided the first course in the fabulous and expressive harmonic structure upon which all of Western music is hung (at least until such modern renegades as Schoenberg and Webern and their ilk reacted against the summation of this system by the likes of Beethoven, Berlioz, Liszt, and Wagner). It seems a quite natural leap from that to Pythagoras' 'harmony of the heavenly bodies.' Because harmony was not predominant in ancient Greek music, it may never have come to Pythagoras' attention (unlike the surprise of irrational numbers) that the natural scales, by purely mathematical ratio, are inexact and thus were resistant to his systemization. That problem may not have emerged until the invention of keyboard instruments and attempts at tempered tuning.

IN A SEPARATE LECTURE (V-m), PREPARED PARTICULARLY FOR STUDENTS OF THE MUSIC CONSERVATORY, THE PYTHAGOREANS' HARMONY OF THE HEAVENS CONCEPT MIGHT BE FURTHER EXPLORED – (Plus, perhaps, KEPLER's Music of the Spheres)
(The main source of that lecture will likely be T. Heath; ARISTARCHUS OF SAMOS: THE ANCIENT COPERNICUS, Ch.XII, "The Pythagoreans"; Dover, 1981 & 2004)

For many (especially those who remember some mathematical training), the **'Pythagorean Theorem'** is what may come first to mind regarding this philosopher, having to do with finding the length of the hypotenuse of any right-angled triangle as the square root of the sum of the squares of the base and height, although it had been well known, in a non-theoretical way (the rule of 3, 4, 5 to establish a right angle) by the priest/surveyors ('rope stretchers') of ancient Egypt for several centuries. It had even been formulated in writing by the Hindu mathematician Baudhayana in 800 B.C. Pythagoras, however, may have proved it. At least, through his cult, he popularized it sufficiently to have become linked with it forever. This theorem, in fact, is often cited as *the beginning of Western mathematics.*



While a group of his followers were on a sea voyage, the story goes, one of the members had an epiphany. Given the master's formula: $a^2 + b^2 = c^2$, what if the base and the height of a triangle were each one unit? Would $1^2 + 1^2 = 2^2$? But then, since $2^2 = 4$. The square root of 4 would give a hypotenuse of 2 units, which is equal to the *sum* of the two sides, *not* the square root of the sum of their squares (and obviously is wrong). Or does $1^2 + 1^2$ become $1 + 1 = 2$, the square root of which is impossible—not because it is a fraction (fractions could be dealt with and resolved in Pythagoras' system) but because

it is an *irrational number*—‘incommensurable’—and his fellows reportedly threw him overboard. There was no place in Pythagoras’ system for an infinite regression of decimal places, and it was looked upon as what we might call a digital virus—an abomination. But the discovery of irrational numbers could not be so easily drowned. The problem seemed to present an impediment to any proof of Pythagoras’ system—so he chose to ignore it and to deny existence to incommensurables.

To consider Pythagoras as having based reality on number may not be exactly right. He was a deep mystic in nature, and much of what he preached and practiced seems rather odd. But he did see the interrelationship of number with sense experience as well as with the metaphysical world, suggesting, at least to later minds, that number is the language of nature, and that the understanding of number would lead to an understanding of the world. He lived and taught and sought this understanding in a religious-like mode, even seeking answers to the mystery of the divine itself, to the degree of founding a kind of priesthood upon these unusual ideas, but one that did not lean on theology.

Pythagoras’ personal contributions to the overall view of his cult is uncertain, since nothing was written. Our knowledge of their beliefs is based on what we have found written by the last of them, Philolaus—much of which is also pretty obscure—and upon what was said and written about them by their admirers and, especially, by their critics. Based upon those reports, it seems Pythagoras was (or at least the Pythagoreans were) *the first in history to consider the Earth as spherical*. How they arrived at this conception is not known, but Sir Thomas Heath [*in* ARISTARCHUS OF SAMOS: *The Ancient Copernicus, etc.*; Oxford, Clarendon Press, 1913] presents three possibilities:

First, since there is no evidence of this idea in preceding history, they may have taken it from the consistently round shadows cast by eclipses, which would mean they understood the true cause of an eclipse prior to the explanation being given by the later Anaxagoras. There is no evidence to support this, however, and it seems certain that Anaxagoras was the first to give the correct explanation.

The *second* possibility noted by Heath is that the Pythagoreans simply extended their conception of a spherical sky to the bodies contained within it.

The *third* (which is Heath’s expectation) is that all of this sphericity was based on the assumption of perfection in the order of the heavens, and the teaching (according to later writings of Diogenes Laertius) that ‘the sphere is the most beautiful of solid figures.’

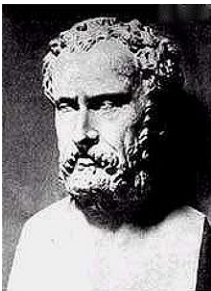
However he or his followers arrived at it, the idea that the Earth was spherical, and that the Universe was geocentric, slowly emerged as the most logical. Even so, it had to be ingeniously supported by unnatural twists and patches to explain the unresolved movements of the planets and the sun. With the backing of Aristotle in the following century, and the amazing summation of it by Ptolemy early in the 3rd century A.D., it was to express the Western world-idea for over 2,000 years—up to the victory of the Copernican revolution (which was delayed even through and well past Kepler and the death of its biggest promoter, Galileo (1564-1642)). The Church implicitly held to it until the 2nd half of the 20th century, when they officially overturned Galileo’s conviction for heresy and blasphemy. (Are we to suppose he was then released from Hell—or that his time in purgatory was at least reduced? More of interest on that in a later lecture.)

Xenophanes & Heraclitus

It must be mentioned that the ideas about reality and the form and workings of the Universe did not develop progressively. The conception of the sphericity of Earth and the sky, and the Sun as a burning rock, etc., did not seem to intimidate later thinkers who chose to ignore or ridicule such ideas. This might be seen as a natural part of the general advancement of good (or, more accurately, ‘the better’ or the ‘more consistent’) ideas, as is seen often in history. Christianity certainly has had a hand in holding back science (witness the Galileo scene), and Islam is prone to that position even today—even though those who are most radical and militant in that unreformed faith, in order to follow their interpretation of scripture in mercilessly eliminating the infidel (all the rest of humanity), now are busy making or buying or capturing atomic weapons, which are based on the most sacrilegious of theories. Perhaps that is one reason many later philosophers wrote and taught in ways that were somewhat obscure—so as to be understood rightly by their few peers and by their best prepared pupils, but harmlessly misunderstood by the non-philosophic many. Their radical ideas (even if true) thus would not corrupt traditions such as to endanger the herd, to weaken the polis, to possibly rend the long established social fabric.

Sometimes this secret way of communicating above the understanding of average folks (behind the text, as it were) has led to such complicated ‘explanations’ as to confound even one’s own followers, not to mention other philosophers. Xenophanes and Heraclitus come to mind as perhaps the best ancient examples.

Xenophanes of Colophon [estimated as 570-478 B.C., some say even later, making him

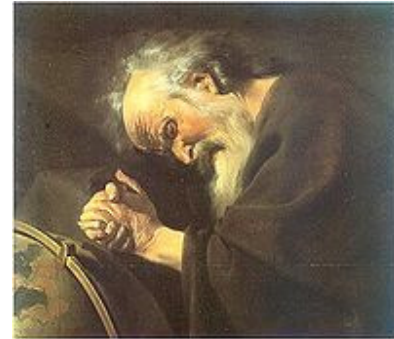


more than 100 years old at his death] opposed the spherical cosmos with an *immoveable and flat Earth*, rooted beneath to infinite extent and with the air above also extending to infinity. His great longevity makes it practically impossible that he was unaware of the Pythagoreans’ spherical ideas and of the well established problems of motion that were slowly being resolved by the concept of heavenly revolutions. Instead of pursuing these more worthy ideas, he explained sunrise and sunset as an illusion. He said the sun proceeds from beyond perception in the East to beyond perception in the west, straight across

the sky, appearing and disappearing as a result of change in distance and finally extinction. *Each day a new sun is formed* and appears seemingly on the horizon. After passing out of sight (or nearly so) in the west, *the sun is actually extinguished*, its fading causing darkness. The same is true of the moon and (presumably) of the planets (though these proceed in the opposite direction). A new sun is a collection of clouds, formed each day out of ‘moist exhalation’ (a concept of evaporation), which burst into flame as they coagulate (the cause of their collection and their precise movement across the sky in a predictable pattern over the course of centuries is not discussed). The moon is similarly explained, its lesser glow due to greater compression of the clouds of which each new moon is formed. The same explanation is given for the stars, comets, and meteors. Eclipses and the phases of the moon are likewise due to partial or complete extinction and rekindling. Some modern historians believe these cruderies are not serious, but were simply meant to poke fun at Thales [*especially* P. Tannery; *Pour l’histoire de la science helléne, de Thalés à Empédocle*, Paris 1887], preserved inadvertently along with other antiques, perhaps by collectors who could not even read them, and presented later as

seriously considered ancient hypotheses. Others take them as dead serious and attempt to reinterpret them, often by great stretches of imagination, so as to actually make them seem progressive and important rather than silly and useless [e.g. Burnet; EARLY GREEK PHILOSOPHY, 2nd edition, 1908], but the contradictions thus created between the reinterpretations of different parts with each other and with the basic cosmic construction of a flat, infinitely deep, and motionless Earth are ultimately unresolvable.

Though he lived after the Pythagoreans, **Heraclitus of Ephesus** [-540s to 480s?] also seems to have taken a retrograde course in his understanding of the cosmos. If we find with him some new ideas of great prescience, his ‘astronomy’ is abominable. He recognizes *no heavenly motions* whatever, considering all these apparent rotations to be illusions based on continuous interchanges between the lower and higher elements, with fire condensing into water which condenses into earth (from higher to lower) and earth melting into water, water vaporizing into air, which in turn vaporizes into fire (lower to higher). He believed there were two distinct kinds of these evaporizations or ‘exhalations’: one arises from the earth, which is dark in nature; the other arises from the sea, which is bright. Night and day, as well as the changing seasons and weather are the result in the variations of these two exhalations. *The stars, planets, moon and sun are but bowls* with their concave side facing the Earth, in which these vapors are collected, producing flames as they transmogrify into fire. Eclipses, as well as the phases of the moon, are due to these bowls turning upward until the light contained therein can no longer be seen. Yet Heraclitus agrees with Xenophanes that there is *a new sun every day* (presumably a recreated moon each night as well), which does not correspond well with his bowl idea. (Are new bowls, too, created each day to contain the sun and moon? How do the bowls seem to move across the sky if movement is an illusion? And how do they return again to the east to contain the next day’s fire?) He seems to have heard something of Indic lore, too, concerning the recurring universe, but he shortened its duration considerably, giving 10,800 solar years as the length of a Great Year (the duration from cosmic birth to its resolution into fire and back to rebirth).



On the other hand, Heraclitus has received considerable respect through the ages for his *theory of flux*. One might see him as the *philosopher of change*. The Greek world was one of stasis, essentially. There was no sense of progress. There was some concern, actually, that there might have been a decline from previous ages: men of gold, who were destroyed and replaced with men of silver, eradicated in their turn and replaced with men of bronze, etc., but in length these ages were beyond the comprehension of most folks, and the general assumption was that today is like yesterday and tomorrow will be not unlike today. In that regard, Heraclitus was a visionary with his suggestion that everything was in flux. It may seem strange, given his understanding of a cosmos without movement, but he did not mean by ‘flux’ that everything was moving in space. It was even more modern than that; more than a proto-theory of motion. He meant everything is becoming and decaying on an elementary level, such that there is no stasis, thus his famous metaphor of the flowing river: “*One can never step into the same river twice,*” by which he meant that reality is merely a succession of transitory states, moving eternally

from insubstantial (fire) to hardest reality and back to fire: a kind of basic insubstantiality that might easily be matched with the modern idea of pure potential (though Heraclitus had not the sophistication of language nor a modernist, mathematically derived logic to so frame it). According to Diogenes Laertius (LIVES OF THE PHILOSOPHERS), his own followers (who may have been rather few, since part of his life was spent as a hermit) said his book was hard to read. This was underscored much later when Socrates was asked to read it and give his opinion: *‘What I understand is splendid; and I think what I do not understand is so too—but it would take a Delian diver to get to the bottom of it.’*

Was Heraclitus, so early, already practicing the art of secret writing, or was his mind as cluttered as his prose? Plato, however, and before him (or through him) Socrates are the philosophers of the ‘noble lie.’ And it is Plato and Aristotle who will compete in the search for cosmic truth in our next session.

The Eleatics

Parmenides of Elea [-5th century] is the founder of the ‘Eleatic’ school.



Perhaps in answer to Heraclitus controversial view that everything is continually changing, Parmenides suggested that nothing changes. He argued, in fact, in a rather proto-modern moment, that the senses cannot be trusted; that the perception of *movement and change is an illusion* and that everything (even the objects in thoughts and dreams) always exists. Whereas Heraclitus, too, held that everything is not what it seems, his reasoning had led to a discrete cosmos, divided into elements in which reduction and reconstruction was the rule. Parmenides seems to have an all-is-eternally-one view, the basis of classical *monism*: that existence (or Being) is oneness, and that our thinking and our sensations tend to break it down into parts in order to process it. It is not easy to follow Parmenides’ arguments as they are put forth in a very esoteric way, as poetry in uneven hexameter, and filled with vagaries and indeterminate symbolism, much of which seems patently false to modern understanding. His underlying assumption seems to be that Being is one and eternal; that it has, therefore, no past or future, but only present. In that sense he might agree with Julian Barbour [THE END OF TIME: *The Next Revolution in Physics*; Oxford, 2000], a modern theoretical physicist who believes (based on logical reasoning, since Einstein’s relativity

vision excludes simultaneity) that time is our illusion. Ideas and real things and even the words that describe them have an equal claim to existence, such that the seeming duality between physics and metaphysics: between mental constructs and hard reality (and even, it seems, the time division into past, present, and future) is only our construct. While the trappings of time and the division of oneness into many (divisions that lead to an infinite absurdity) seem necessary for us to function, at bottom *the world is one, eternal, and inseparable*. It must be said that, for me, Barbour’s book (though not written in verse) is at least as hard to read today as those of Parmenides and Heraclitus must have been in their day—which is not necessarily favorable to truth.

The stand-off in this battle between the indivisible cosmic oneness of the Eleatics and the elementary building-blocks ideas of ‘atomists,’ ‘vaporists,’ and/or ‘transitionists’ was illustrated by Parmenides’ illustrious pupil, **Zeno** [of Elea, -450?], by means of his famous *paradoxes*. He pointed out in his attack on those who saw the world as made up of a collection of tiny (even if infinitely tiny) elements that were ever-changing in the formation and decay of ‘objects,’ that, by their own theory, nothing could actually occur. If things tend toward change, they must change by half before they are actually changed. Then they must change by half of the remaining half, then by half of the remaining quarter, etc. etc. *ad infinitum*, so that they never can be fully changed—the arrow cannot move from one place in space to the next—the runner can never reach the goal—Achilles can never overtake the tortoise.

This is a telling moment. Zeno’s intent is not to defy reality, but to prove by logical procedure that the ‘discrete’ view of the world is wrong. Is there something wrong in Zeno’s line of reasoning? But here is the best illustration of how the ancients’ assumptions and their clinging to logical progression and theories, despite the often blatant contradiction of observation, prevented them from stepping beyond their cultural confines. Zeno still pesters modern logicians, but the rest of us, seeing science today as a weapon against nature rather than a means to truth, only smile, since all his devilishly clever arguments do not, of course, prevent Achilles victory over the turtle.

Empedocles

Empedocles of Argrigentum [494?-434 B.C.], supposedly a pupil of Parmenides.



Empedocles.

He is said (by Aristotle) to have been *the inventor of rhetoric* as a method; a course of study or craft. Like most of the pre-Socratics, he was also a poet and presented his discourses on cosmology in meter. He generally followed Anaximenes in considering the heavens to be a transparent sphere with stars attached, though his particular version of the sphere was an oblate spheroid, wider than it was ‘tall.’ There is confusion as to his conception of the sun, several different writers in later ages attributing various and often conflicting ideas about this to Empedocles, but he may have understood it as a reflection, on the inner surface of the crystalline sphere, of the ‘central fire’ (around which the Earth and its ‘counter-earth’ both revolved), such that for him, as for the later Pythagoreans as they refined and adjusted their master’s vision, *the universe was neither geocentric nor heliocentric*.

We also are undecided about his view of the Earth as a sphere (with the Pythagoreans—or perhaps it was only the last of them, Philolaus who saw it as a globe) or flat (as with Anaxagoras). It seems likely he considered it flat, for the Earth as a short, wide cylinder, would be most conducive to his idea of the counter-earth of the same form: the living, out-facing surfaces of the two always facing away from each other as well as away from the central fire around which they rotated. Empedocles was among the first, if not the originator, to conceive of the moon’s light as merely a reflection of the sun. In fact, the counter-earth idea seems to have been invented for no better purpose than to explain what seemed to be a greater number of Lunar eclipses than could be explained

by the shadow cast by the Earth. In this scenario it would be easy to envision some sort of physical continuance or connection between Earth and Counter-earth extending through the central fire, or even a single cylinder, Earth being one end and Counter-earth on the other, but this does not seem to have occurred to anyone.

Empedocles has the distinction as the first man known to have conceived of the *movement of light*; that is its taking time (however unperceived due to its great speed) to travel from source to observer. He did not, however, leave us a description of light (either as particles or waves), nor did he in any way foretell the theory of relativity. Aristotle would later credit this traveling of light idea to Empedocles while he, himself, rejected it in favor of his view that the medium (æther) could change all at once, as a body of water freezes simultaneously as a unit. There is also some confusion in Aristotle's view (also adapted from others) regarding light rays emitting from our eyes (from the element of fire within, which may have made up the soul) as well as reflecting back into them.

Empedocles is also the first to assign a kind of *mechanical motivation via the opposing principles of love and strife*. One is tempted to say he suggested a materialist foundation for what are essentially feelings or moods, but there is no evidence that he said anything so explicit in that regard. *Love* was like consonance in harmony, acting as an attractive 'force;' tending to form disparate things into new reality; tending toward unification or oneness. *Strife*, on the other hand, corresponded to dissonance, a repelling and separating 'force': tending toward chaos. By the interaction and the alternation of the primacy of these two eternal principles or 'tendencies', continual change is effected and even the overall cyclical nature of the material world is explained (from near oneness to near nothingness and back again), while the totality of substance remains the same. In his own terms [*translator unknown*]:

Thus insofar as they [the elements] have learned to become one from many and again become many as the one grows apart, to that extent they come into being and have no lasting life; but insofar as they never cease their continual change, to that extent they exist forever, unmoving in a circle [cycle].

There is, for him, no creation out of nothingness, and when we say 'creation' we must therefore mean only the purposeful organization of pre-existing 'things' or elements. Here are taken the earliest recorded steps toward the first law of thermodynamics (not codified until the 19th century by Carnot and refined by Clausius, Gibbs, Lord Kelvin, Helmholtz, Maxwell, Ludwig Boltzman [in connection with the gas law], *et al*): the *conservation of energy*. So Empedocles' universe was appropriately endless (timeless), even though it was finite in content.

Empedocles is also perhaps the earliest to form an idea of evolution, including an out of kilter vision of the process of survival of the fittest. The question of whether or not to take Empedocles seriously—in anything—arises when we hear of his concept of the primeval world, where 'neckless heads sprang up; naked arms strayed about, devoid of shoulders; and eyes wandered alone, begging for foreheads'. 'Many grew double-headed, double-chested; man-faced oxen arose, and again ox-headed men—creatures mixed partly from male partly from female form, fitted with dark limbs'. These weird creatures apparently struggled with each other and thus forward toward the ideal: the human form—a process implying progress: certainly a vast improvement over primordial chaos, and tending toward order, as opposed to what we consider to have been the general ancient Greek notion; that of either stasis or decline from a once perfect golden age.

Anaxagoras

Anaxagoras of Clazomenae, born about 500 B.C., spent most of his life in Periclean



Athens as a favorite of Pericles himself. He survived due to that favoritism when he was under attack for the blasphemy of claiming *the sun was a huge and distant burning rock and that the moon was made of earthlike substance*. This does not gibe, however, with his concurrence with the Milesian school: that both were discs rather than spheres, and that the Earth was flat, and (in agreement with Anaximenes) that it rides upon the air something like a colossal frisbie. It could be that he changed his mind in that regard, but both positions were forwarded to the future. It seems likely he did change his mind, as his major contribution to ancient astronomy was his (basically correct) *explanation of eclipses as shadows* (though he surmised that the shadows were most often cast by other bodies ‘below the Earth’—perhaps including the ‘counter-earth’),

and that the *moon shines only by reflecting the light of the sun*. Since the shadows were always perfectly round, the globular Earth hypothesis would seem the best fit, even though no one had any idea how material and animals would be held to the outside of a sphere, unless they were pushed inward, as if it were downward, toward the center of the universe.

After Pericles fall from power, Anaxagoras’ *materialism* got him into trouble with the ancient Greek version of the religious right, and he fled to Lampsacus. While he leaned toward the earlier Milesian school, particularly Anaximenes, he also agreed with Empedocles about eternal existence, but excluded the impetus of love and strife. He held that everything was infinitely divisible, but at every stage of reduction the essence of the cosmos was still contained in even the tiniest flake: the whole contained in every part. Here, from this ancient proto-type of the 20th century’s David Bohm, was the embryonic suggestion of *wholistic theory*, an idea that has born fruit in the modern technology of holographic imagery and that is still in the running for the ‘true’ understanding of the nature of the cosmos [see Briggs & Peat; LOOKING GLASS UNIVERSE: *The Emerging Science of Wholeness*; Cornerstone Library (Simon & Schuster), NY, 1984].

For Anaxagoras, a *universal mind* seems to be the overall ordering principle. Although it somehow controls all things, we have no record of his concept of the nature of mind nor how it works to control the material world. This was a great disappointment to Plato when he learned about it in the next century. But he has Socrates mention that when he first heard a discussion concerning Anaxagoras’ mind-over-matter idea he exulted. Aristotle seems to tell the same story about himself, but then it was discovered “he (Anaxagoras) did not ascribe to it any explanations for the arranging of things, but found explanations in air and æther and water and many other absurdities.”

It was Anaxagoras who conceived of *creation out of a vortex*—a kind of primordial cyclone driven by mind—in which, by centrifugal force, the chaotic elementals were whirled about and gathered into bodies and substances. Aristotle accused him of confusing *nous* and *psyche*: the known with the knowing. And Plato (in his *Phaedo*) has Socrates complain that this cosmogony of Anaxagoras is merely a means of gaining existence by a kind of accident: a mechanism without a predetermined design or awareness of purpose. In any case, the idea did not gain much popularity in ancient Greece, but had significant impact on later cosmogonic theorizing, particularly that of Descartes. And it was “of precisely the same kind as the theory of Kant and Laplace assumes for the formation of the solar system”. [from Heath, ARISTARCHUS OF SAMOS: *the Ancient Copernicus*; Clarendon Press, Oxford, 1913]

It was also Anaxagoras who first recorded the idea—that is to say to admit there was a possibility—that other worlds might exist

...with other men and other animals, and that they have a sun and moon and the rest as with us...

[from a preserved fragment of Anaxagoras, *ibid.*].

We have noticed various concepts of a mechanical or pseudo-mechanical nature, as well as variations on the theosophic view of the world by our Greek precursors. This was likely reflective of their decentralized political situation. In fact, while there were Greeks (as opposed to barbarians and ‘others’—Egyptians, Persians, etc.), there was no actual Greece, that is in today’s sense of a ‘nation,’ but only many, widespread elements of a still forming Greek ‘type,’ suggestive of the ideas presented by the atomists of the many unwitting parts hanging together to make up a whole. There was, of course, strife between the parts, and they often practically annihilated one another, but that, for the most part, had to do with secular disputes rather than religious doctrine. They naturally called upon their gods and made sacrifices to get their attention, but did not attempt to convert their enemies—only to kill or enslave them or (so old is the concept of later Mafiosi) to bind them into paying tribute via the protection racket. The gods of other cities, other civilizations, and even those of barbarians were accepted as real (albeit somewhat inferior to one’s own gods, as proven by victory). That seems to be the case, generally, throughout antiquity (with a few, short-lived exceptions—most notably the Zoroastrian Persians) nearly to the end of the Roman Empire. At that point, Christianity tried to conquer, in a semi-metaphysical sense, by spreading their gospel, though they sometimes forcefully subjugated the population—for the good of the immortal souls of the heathen, of course. And then Islam expanded by beheading all non-believers for the good of the soul of the executioner. Both movements believed they were acting on instructions by the one and only God; the true God who was interested, for some unknown reason, in eradicating false belief at practically any cost. The pagans, generally did not consider opposing gods as having been destroyed, but only defeated; humiliated, perhaps, within the pantheon. Although, in the not unusual cases where all the adult male citizens were slaughtered and the children and females enslaved, recovery of respect for such defeated gods would seem to have been difficult.

The political situation: the multitude of city-states instead of a centralized government may have had some influence in the discrete concept of reality as proposed by the early Greek atomists.

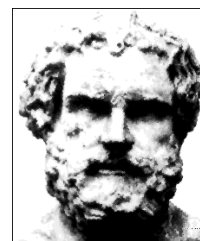
Leucippus and Democritus

Leucippus was born c.440 B.C. in either Miletus or Elea, and is the more elusive of the two. We cannot be sure of his contributions to this new idea, since the bulk of later writers (particularly Epicurus, and later the Roman poet/philosopher Lucretius, who especially popularized and immortalized the idea) have credited almost all of the earliest atomic theory to his disciple,



Democritus of Abdera [460-370 B.C.]

Democritus (or *Demokritos*) overshadowed his master by elaborating the theory and writing over 70 books (some of which survived via Epicurus). The atomists saw the monism of their predecessors as a



dead end (though it still survives philosophically today), and they found a way to avoid it. They began by understanding space as a sort of receptacle of 'things,' a receptacle that could be conceived as empty. Though there were temporary patches of emptiness, of course there could never be 'total emptiness,' as the atoms were eternal and always in motion. This idea was mainly ignored by their contemporaries, but hung about for centuries to become the absolute space and absolute time of the Newtonian cosmos, and the launching pad for modern atomic theory.

Change, for the early atomists, was far from an illusion. It was real and it was explained by the continual movement and combining and recombining of indestructible atoms: the building blocks of matter, such that nature consists, as Lucretius would say, 'of nothing but atoms and the void.' There were many sorts of atoms. How many or what was the difference could not be determined since they were all much too small to be perceived. They may have had mass, however, since Democritus mentioned, somewhat obscurely, that 'the more any indivisible exceeds, the heavier it is.' In any case they were of many shapes and sizes, such that they could combine in various ways, or bounce off each other like billiard balls. Here is the first attempt at a purely mechanical physics, in which there was no place for purpose or for a Prime Mover or for whims and inventions of anthropomorphic gods. Even mind and soul were conceived as atomically derived. But why did the atoms move? Democritus did not pretend to know why, but only how: randomly, 'like motes in sunbeams when there is no wind'; much as the molecules of gas in Boltzman's kinetic theory, which had to wait for the 19th century to be discovered. Here we had the first notion of a reality based on chance. Or was it probability?

Most people are uncomfortable with such a meaningless world. We resist the idea that existence and even mind results only from the random collisions of thoughtless particles. Despite their political separateness (the discrete relationships of the multitude of city-states in ancient Greece), this many-particles idea of reality was too much for the folk to digest, and came way too early in history. The multitude of deities (different gods and different versions of the same gods) seemed to supply sufficient reflection of the Greeks' rather loose political reality. At least they could pray to their various gods and understand something of their nature. Atomic theory, without the cloak of modern science and advanced mathematics to soften its starkness, suffered from lack of appeal. It was forgotten because it gave no comfort nor seemed of any value whatever. Leucippus and Democritus were like piano savants born before the invention of the keyboard.

Empedocles might have imagined the Greeks as somehow suspended between his opposing principles of Love and Strife. Love, however, did not seem the equal of strife—at least not at this time in history. Contrary to his expectations regarding the material world, the city-states congregated now and then into federations for security through fear (i.e., through *strife*, not love), the greater *fear* of certain aggressive other cities pressed upon them rather than drawing them together, and the very same repelling force (fear) again split their uneasy conglomerations as soon as the aggressors were defeated—or were busy elsewhere and, in any case, no longer were perceived as threatening. Thus it was not love *and* strife but the randomly shifting level of strife alone that was imminent in their world, and they were continually coming together in these pragmatic but loose federations of cities, only to see them fall apart again. Worse: even when certain cities enjoyed peace between one another, they then intensified internal conflict—and not merely between leaders but even between principles of leadership and ideals of government: Should *one*, *a few* strong and/or worthy, or *the many* rule? How fitting that atomic theory—essentially the idea of ‘one out of many’—should be proposed so improbably by a man named Democritus!

The very multitude of conflicting cosmic visions, the logic-games played in posing them against one another, and especially the lack of any means (such as the scientific method) of resolving their differences or proving them one way or another, seems to have prevented any them from being taken seriously and perhaps blocked the early development of physics. These many ‘philosophies’, thus had little effect, therefore, on the civilization which spawned them. For the Greeks, generally, whether or not there was an original cosmic creation, the world would be forever what it was. It was not malleable. Men could only experience it; continue on either as they always had and always would, or until the gods who made them and the world in which they lived destroyed it and made another. So they lived almost entirely in the moment.

Fortune, indeed, might seem to be influenced by obeisance or ritual and/or sacrifice, especially if the cosmos was based on or motivated by ‘mind.’ The gods had their own agendas, however; were constantly in conflict among themselves; and often were irascible. It apparently did not occur to anyone, even to those who doubted the gods, that humans might have some influence over reality; that they, themselves, might make alterations to the way of the world; or (a crucial concept) that nature could be tamed and harnessed. Their *theorizing had no practical side* beyond the pleasure of puzzling. Those who thought the world was an illusion saw it as impossible to understand and made no effort to do so. Those who accepted what they perceived to be real did not expect that it could be altered, so they didn’t try. In either case, humans were helplessly involved. While some believed that nothing ever changed, others believed there had been a golden age from which they had declined (and might continue to do so until the world crumbled completely and was reformed). Perhaps there were some who hoped they might see better times: progressives in some sense. But even for these few, all such things were in the hands of fate or the gods and were, in any case, beyond human control.

Required reading for next session:

HAND OUTS: *applicable selection from Plato: Timaeus* (pp.447-452 of PLATO GBWW—Jowett Translation);

AND: (by Sir Thomas Heath) ARISTARCHUS OF SAMOS: *The Ancient Copernicus* (*if it is not included in the assigned books for this course—undecided at this point*), chapters XVI 'The Theory of Concentric Spheres: Eudoxus, Callippus, and Aristotle' and XVII 'Aristotle, cont.' (pp.190-248)—Dover edition, 2004 of Oxford (Clarendon Press) 1913);

ALSO: *The Clouds*; Aristophanes.