

## **COSMOLOGY without HEADACHES**

(Lecture Series)

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

Aristophanes: CLOUDS papers to be submitted at this class session, and some time allowed for discussion before proceeding to this lecture.

### **LECTURE VII: Decay of Greece; Rise of Rome; War & Law Trump Philosophy**

Before we move our focus to Italy, a few more details need to be added to the Greek cosmic systems that were about to be absorbed by Rome. We have discussed only the best known of the many systems or pseudo-systems proposed by these ancient men. They are shrouded in mystery and historians are still debating over exactly what they meant to convey in the tiny fragments or ghosts of fragments that have been somehow preserved. Only Aristotle, it seems, took the trouble to sift through prior concepts to find the most likely and/or most ‘phenomena saving’ versions of the heavenly machinery with the idea of finding something like knowledge and truth. The others, if they taught at all, went on teaching their own concepts and seem to have made little, if any effort to compromise or meld or even compare their visions with other theories.

The last of the followers of Pythagoras had passed away by the time of Alexander, leaving the ideas of the counter-earth and/or the revolution of the Earth about a central fire without advocates (even this quasi-religious brotherhood could not present a solid front on cosmology). A student of Plato, **Heraclides of Pontus** [c.388-312 B.C.], many of whose ideas are of Platonic origin (such as the souls returning from the heavens) believed the Universe to be a god itself, as were the planets, the stars, and the earth. He also thought the Universe was infinite, and believed each star was a whole world—like a mini-cosmos, with its own planets, an earth, and an atmosphere or æther. He believed our moon was like another earth, only surrounded by a reflective mist.

All this was unscientific and unprovable, of course, but Heraclides and/or (possibly) an obscure thinker called Ecphantus (if he even existed) stepped beyond Plato (and beyond everyone) in astronomical perception and came close to solving the problem of planetary motion by having Venus and Mercury revolve about the sun. But he (they) kept Earth at the center of the whole system. He (they) also may have had the Earth rotating about its own axis while the heavens were fixed, rather than the Earth being unmoved (as apparently was the case with Plato). [Show diagram from p.263 of Heath.] The next logical step would be to have *all* the planets as satellites of the sun (except Earth, which would be unmoved at the center of the sun’s orbit). By this view the planets closer to the sun (Venus and Mercury) would always be interior to the position of the Earth relative to the Sun’s orbit around Earth, and the outer planets, Mars, Jupiter, and Saturn would sometimes seem interior, and sometimes exterior to the position of the Earth relative to the sun’s movement—the sun thus carried the whole planetary system with it (possibly explaining by this the differing distances from the Earth that are suggested by the alternating dimness and brightness of the closer planets—a major problem that Aristotle, though he argues against Heraclides, couldn’t solve himself). The moon, in this new configuration, remained a satellite only of Earth.

This was a departure altogether from the system of concentric spheres. It was an *eccentric* system, and because of that, was soon to be forgotten. It was essentially, centuries later, the system of Tycho Brae and was competitive for a while, in his era, with the Ptolemaic system inherited from Aristotle. Due in part to its considerable success and longevity, and in part because it did not violate Genesis and thus could be merged with scripture, and so was accepted by the Church, nothing would challenge the Ptolemaic version until the Copernican heliocentric arrangement (actually proposed [c1500] before Tycho-Brae) began to be accepted in the late 17<sup>th</sup> century. All of these systems, of course (before Galileo), were ingenious pre-telescopic notions, and for the most part (due mainly to their retaining of *anthropocentricity*) were considered harmless mathematical and geometrical curiosities rather than serious propositions about God's world.

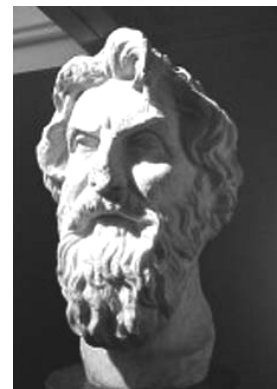
Due to the major loss of ancient Greek original writings, there is disagreement about who thought of what, and when. Several historians, even some specializing in ancient astronomy, have interpreted Heraclides' ideas as heliocentric, thus pre-empting Copernicus. But generally it is thought that Earth still held the center of all the systems previously discussed. While Heraclides had the planets revolving about the sun, the Earth was not actually understood to be a planet, and the sun itself, carrying its several satellites with it, still revolved about the Earth—everything turning about the geo-center.

At about the same time, the hard-to-relinquish idea of concentric spheres was upgraded by the addition of epicycles, a system Aristotle generally approved: essentially the system that would be refined by Ptolemy. The Greeks had an aversion to eccentric systems because of their deep-seated assumption of divine perfection, including perfectly circular orbits. It was more important to them to keep these revolutions circular than to explain the erratic movements of the planets by the comparatively ugly asymmetry introduced by Heraclides. The addition of epicycles to 'preserve the phenomena' seemed to explain the observed/recorded motions and all their correlations more consistently, and such a system seemed to the ancients to be less ugly (however cluttered it may seem to moderns) than putting Earth in motion when it was so obviously at rest.

The divine perfection assumption was not forgotten by later ages. In fact it was not until Kepler than anyone (that we know of) mentioned again the possibility of elliptical orbits. They just *had* to be circles or spheres, as the divine must be perfect, and every imaginable contrivance was brought to bear to keep them round while still 'saving the phenomena'.

#### **Aristarchus of Samos** [c310-230 B.C.]

may actually have hit upon the Copernican heliocentric system (at least that is Heath's view, and it is based upon a remarkable amount of research), but that vision was rejected, even by Aristarchus himself—even by the great genius Archimedes, apparently. It was likely forgotten because observed planetary motions and timing could not be demonstrated by a heliocentric model with perfectly circular orbits. Plus the ancients had a hard time accepting even a rotating Earth, let alone a revolving one, as there was no sensation or otherwise convincing evidence that it was moving at all. Cosmic views other than the accepted Ptolemaic version—basically the crystalline spheres of Aristotle—persisted at least until the European Reformation, and for most folks, well beyond it.



Beyond his radical theorizing concerning the layout and working of the Universe, Aristarchus did a lot of measuring by means of geometry—actually round-a-bout ‘almost-trigonometry’ (though as a system trigonometry had not yet been invented). We are not privy to his estimate for the size of the Earth, but Heath thinks it likely he agreed with Dicaearchus—300,000 stades (29,360 miles), as did the later science & math genius, Archimedes. The instruments available for observation and measurement were primitive, so he invented some of his own in an attempt to refine some of Eudoxus’ more ancient results concerning the size ratios of Earth, moon, and sun. If the estimates of Aristarchus are not terribly accurate, he at least served to inspire later astronomers and mathematicians to better calculations—notably:



**Archimedes** [287-212 B.C.], famous for his invention of the science of hydrostatics via discovery of the displacement of water (Archimedes’ Principle) and for the Archimedes screw (a lift type pump that much improved irrigation, still in use in Egypt), was one of the ancient world’s great geometers (especially renowned for solving for the area of conic sections, etc.). He estimated (in a work called the *Sand Reckoner*) the number of grains of sand it would take to fill the Universe, and invented a number of weapons and war machines for Syracuse (extreme catapults and giant cranes that reportedly could lift entire ships out of the water and capsizе them—even, it was said, used a giant magnifying lens to concentrate the sun’s rays and set ships afire up to half-a-mile away [unverified]);



**Eratosthenes** [275-195 B.C.], especially famous for his nearly accurate estimate of the size of Earth (252,000 stades in circumference, or 7,850 miles in diameter—only about 50 miles short of true pole to pole distance) while he was in charge of the great library of Alexandria; and



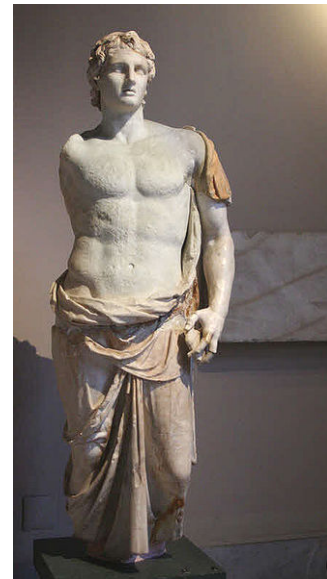
**Hipparchus** [c.130 B.C.], who gave the world its first star catalogue, was first to assign a magnitude of brightness system to the stars, discovered precession in movement of Earth’s axis, gave a fairly close estimate of the size of the moon, and probably anticipated Tycho-Brae’s version of the cosmos. Hipparchus’ version was forgotten, however, and had to wait for the Renaissance to be reconceived—but then it was too late: more than a century *after* Copernicus had already mathematically invented (or, more appropriately, perhaps, ‘rediscovered’ the view of Aristarchus) and propounded the heliocentric solar system).

These men were on the very threshold of scientific modernity. These later Greek cosmological ideas, however, while some may look more advanced than others from our modern perspective, were, for the most part, shots in the dark that led to more questions than solutions of the astronomical problem—or solutions to any problems beyond sheer geometry. But they were the earliest attempts at non-theological, purely mechanistic concepts of reality. We must also note that without the benefit of printing and instant distribution, these ideas were not only restricted in their own time of ‘publication,’ but surely were distorted in transmission across the centuries—especially after loss of the originals. In some cases there may have been no originals; only oral transmission. Furthermore, the political situation in Greece consisted of many small, wide-spread city-

states, envious and fearful of one another and all trying to be autonomous, instead of a centralized proto-nation or a true empire such as Egypt. So these new ideas might not have been well circulated, having little effect on average citizens. Continuing cosmic tinkering by ‘experts’ did not generally impinge on common religious beliefs or political views—until much later, that is, when the Greeks took on a larger identity as a ‘people’ (**Hellenes**) and as a sort of sometimes pseudo-nation through the many failed attempts at federation (especially in hope of defending themselves against Persian intrusions).

This might be seen as having much to do with the seeming natural tendency to draw together in fear, and to divide again after the security of victory. But the Greeks seemed immune to that general rule. Many of the city-states saw a Persian invasion as an opportunity to get out from under the ‘influence’ of their more powerful near-neighbors, and many even colluded with the Persians, considering that it might be better to pay some not unreasonable tax in tribute to a far away king than to be politically oppressed by an intrusive neighbor—or subject to a mob-like demos. There was perhaps a misty dream of general Greek alliance nurtured by such as the Hellenic League at the time of Aristotle and his amazing work at collecting world knowledge. There might also have been some twinge of pride in the spread of Hellenism (in the aftermath of Alexander’s conquests, even though the Macedonians had effectively conquered Greece, generally mistrusted Greeks, and were considered only poor imitators of Greekness) and the cosmopolitan effects stemming from the short-lived and ill-fated Alexandrian empire.

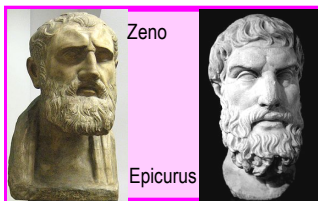
On the other hand, Alexander’s incredibly advanced globalism (Could he have got this from Aristotle?) was beyond the understanding of the Macedonian phalanx as well as his Greek mercenaries. His dreams of merging races and blending bloodlines were much too futuristic (at least unrealistic), insisting that his generals and bureaucrats take barbarian wives, raise their mongrel children, and mix with their conquered people, as he, himself took a Bactrian princess (Roxane) as his bride (who gave him a son, further confusing the inheritance of imperial authority upon his death). He had lost touch. In his long absence, he had not only severed ties with his native Macedon, but by becoming a god he also broke whatever connection he may have once had with humanity. At the peak of his tyrannical fantasy he thought he could simply order the new attitude and a new world would be accomplished. He was hardly the first and certainly not the last to have such grandiose expectations. Even had they been accepting of this radical ideal, however, neither Greeks nor Macedonians could have helped him realize it. They were incapable of their own unification, let alone of coercing a pre-Christian world to join hands around the Mediterranean. If a relatively homogeneous folk, with common language and traditions, and a similar way of life—even seeing themselves as ‘Greeks’ or ‘Hellenes’—cannot combine to realize a peaceful regime on a small peninsula and a smattering of tiny islands, how will a riotously multicultural whole world resolve differences without submitting to a supreme authority, relinquishing their traditions (or trivializing them), and allowing their values to be blended with their opposites (i.e., lost) and/or their beliefs to be crushed under an iron heel?



The world-enlarging changes wrought by Alexander certainly extended Hellenism. Despite the immediate fragmentation of this god-king's empire after his death, the Greek way of understanding the world; the science and logic-oriented outlook, along with the new Greek cosmos, radiated throughout the Mediterranean world. Even after the crumbling of Rome, Hellenism continued to affect thought and religion, as it mated, albeit in a twisted way, with Christianity to give birth to Western Civilization (after a much prolonged gestation, called the 'Medieval Period'). Some would say the Greek way was tamed by Christianity. Its tendency toward secularism, at least, was thereby curbed. But Hellenism was too vital, too life affirming to be snuffed by piety. In fact, its remnants still have their effect today. If the Greeks could have stopped the internecine bickering to emerge from their precious *poleis* to form something resembling a nation, this great expansion of their influence might have eventually stretched the bubble of purely theoretical science to the bursting point, and something like the modern world might have been born before Christ. But they wore themselves out in wars between brothers (Greece's demise came mainly at the hands of Philip's Macedonian phalanx), and they were in no shape to impede conquest by the Romans.

It is also important to note that outward-looking philosophy, developing since the 5<sup>th</sup> century B.C., seems to have reached its limit. Perhaps this was due to a loss of spirit under the hegemony of Macedon—considering Macedonian troops were garrisoned in the major Greek cities (particularly Athens), which gave the lie to ideas about the *poleis* political autonomy. Perhaps it was a residual fear out of the memory of what happened to the legendary hero of philosophy, Socrates, that turned philosophy in a direction that would seem to be inoffensive to the occupiers. Also, after Plato's death, his Academy (under Xenocrates, after Speusippus' suicide) lost much of its appeal and turned away from things like 'first philosophy' and 'what is reality?'—i.e., scientific pursuits—and concerned itself more and more with questions of ethics. "The reason for the discovery of philosophy is to allay that which causes disturbance in life," said Xenocrates [as quoted in F.W.Walbank: THE HELLENISTIC WORLD; Harvard, 1992; p.178].

Aristotle's school fared little better. His heir, Theophrastus, kept up research, as did his successor, Strato. With Strato's passing (c.-270) the Lyceum's reputation also



declined. Was it **Zeno's stoicism** or **Epicurean pleasure-seeking** or an atmosphere pungent with the **cynicism of Diogenes** living in his tub?—whatever the cause, philosophy turned inward to answer human problems.



In a sense, if philosophy is defined as truth-seeking, none of the last three mentioned movements is really philosophy. This is one man's opinion, but these seem rather like codes of behavior based on 'philosophizing,' in only the most general sense of that term: by the use of logical arguments. 'Rationalizing' would be more accurate, due actually to the *failure* of philosophy to find answers to: 'What is justice?' and 'What is truth?'—'What is reality?' These questions are not the true focus of stoicism and Epicureanism—nor especially of cynicism, which denies there can be answers at all, thus rendering philosophy absurd (yet all three have the temerity to present themselves as 'philosophy'—or worse, as 'philosophies'—which is our condition today).

Whereas real philosophy had sought final truth(s), applicable everywhere and to all, now it was happiness or merely contentment—or simply an escape into euphoria that is posited as the goal of reason. Acceptance and making the best of one's situation becomes the stoic admonition, a return of the 'don't fight it' syndrome of Taoism and Confucianism, a very old oriental attitude. It may be that this empty hopelessness is a symptom of decline in a civilization (per Oswald Spengler): the tendency of thinkers to look inward for peace and happiness (or at least the rising popularity of such thought-systems) rather than apparently wasting time and energy on trying to understand or, worse, to manipulate the world by the force of ideas (a world unyielding before our efforts, anyway, and basically incomprehensible). Looking inward rather than out; casting one's eyes downward, so as to avoid the meaninglessness, chaos, and especially the dangers presented by the real world, is not a symptom of cultural health and vitality. To these particular thinkers (Zeno and Epicurus and their followers and imitators) social idealism (the extreme of which is a kind of altruistic submission) has seemed to fail and is replaced by asceticism: a selfish back-turning on the part of the Epicureans in a search for personal pleasure, and, in the case of the Stoa, by the conquering of desire and the emotionless acceptance of one's 'thrown' condition: one's lot. Neither mode is progressive; perhaps not even natural. This inheritance may have a great deal to do with the relative stagnation of both thought and society in Rome and, later (when mixed with the anti-worldly theological focus of Christianity), with the development and maintenance of the 'dark' aspect: the general stagnation of the West's medieval period.

Compared to the Greeks, Romans generally cared less about philosophy. The educated aristocracy, though they may have had a brush with philosophy from their Greek tutors, were bent more toward increasing power and wealth; focusing on things political and military. The uneducated had neither time nor inclination to pursue much beyond subsistence. The military offered a reasonable wage and a chance at upward mobility for qualified men (not to mention booty and perhaps a plot of 'spear-won' land for those who survived to retirement) and opportunities for great wealth to those who held political power. The energetic Romans managed to conquer the weary Greeks before Greece had either completed its natural cultural aging and decline or snapped out of it to begin some sort of modern metamorphosis. Alexander had shown that the world could be conquered. Rome would show how it could be ruled. If the Greeks gave us philosophy, the Romans gave us law, engineering, administration, and big public works—roads, government, sewers, and litigation. "The typical educated Roman," says Will Durant,

...was orderly, conservative, loyal, sober, reverent, tenacious, severe, practical. He enjoyed discipline, and would have no nonsense about liberty. He obeyed as a training for command. He took it for granted that the government had a right to inquire into his morals as well as his income, and to value him purely according to his services to the state. He distrusted individuality and genius. He had none of the charm, vivacity, and unstable fluency of the Attic intellect; and organization was his forte. He lacked imagination, even to make a mythology of his own. He could, with some effort love beauty, but he could seldom create it. He had no use for pure science, and was suspicious of philosophy as a devilish dissolvent of ancient beliefs and ways. He could not, for the life of him, understand Plato, or Archimedes, or Christ. He could only rule the world.

And further on he notes:

The Romans used geometry well in building and engineering, but added not one theorem to that rounded achievement of the Greek mind. We hear nothing of astronomy in this period except its blundering calendar and its preposterous sister or mother—astrology.

[CAESAR AND CHRIST, Ch.IV: *Stoic Rome*; pp.71-72 & 75]

The remnants of Greek philosophy were drained away from the native soil as Greece declined and, among Patricians, it became *de rigueur* to have Greek slave-philosophers brought to Rome as tutors for one's children. In about 175 B.C., after Perseus (King of Macedon and son of Philip V) was defeated at Pydna by Lucius Aemilius Paulus, a thousand Greek leaders, including the historian **Polybius** [c200-c120 B.C.], were taken as hostages to Italy. Medicine fared about the same. The first freeman physician in Rome was a Greek, Archagathus. He gained considerable fame and soon Greek physicians (most of them probably from Alexandria) flocked to Rome to make medicine, like philosophy and mathematics, a Greek monopoly. Although Athens held tenaciously to the title 'educator of Greece', the center of civilization (that is to say, the Mediterranean-based world) for several generations was Alexandria—in (but not of) Egypt. By 150 B.C. Greece and Macedon were made into a Roman province. Athens (out of respect for its historical peaks of culture) and Sparta (perhaps due to the Romans' respect for its famous military based anti-culture) were the only two cities to keep their own laws. It was the last straw, and Greece effectively disappeared from political history—but certainly not from cultural history. As **Cicero** [106-43 B.C.] put it, "It was no little brook that flowed from Greece into our city, but a mighty river of culture and learning"; and **Horace** [65-8 B.C.; favored poet of Caesar Augustus] would claim, "*Graecia capta ferum victorem cepit*" (Greece captivated her barbarous captor).

After its temporary residence in Alexandria, the center of Mediterranean civilization tended westward to Rome, whose most fortune-blessed children, even under the empire, were still sent to Athens for refinement and philosophy, and to Alexandria for worldliness and medical school (Galen, et al).

After **Seneca** [4 B.C. to 65 A.D.], who tried to restrain the worst excesses of Nero, was commanded to commit suicide, the slave **Epictetus** [55-135 A.D.] was the carrier of Stoicism until he, along with all philosophers, was expelled from Rome by Domitian, c.90 A.D. But stoicism held on due to its long association with the Roman character and one of its greatest exponents becoming Emperor:

**Marcus Aurelius** [121-180 A.D.].

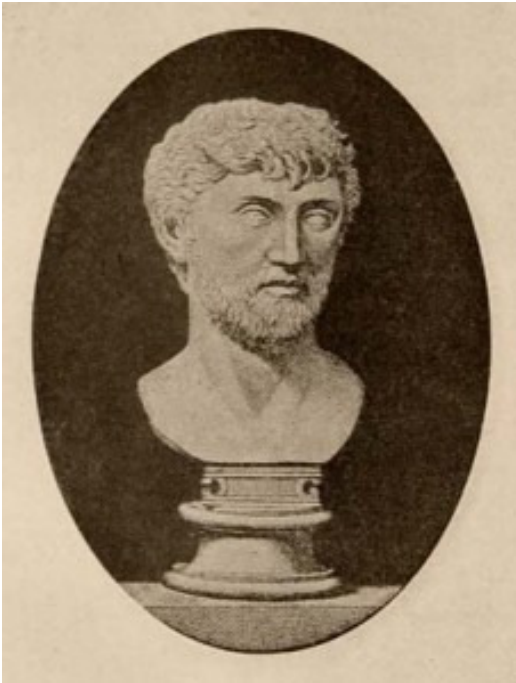
"It is either a well-arranged universe," he considers, "or a chaos huddled together." Assuming the former from its complicated organization, he reasons it is governed by providence rather than by chance and accepts his place and destiny. "Everything harmonizes with me," he believes, "which is harmonious to thee, O Universe." [GBWW: SYNTIPICON II; ch.102. *World*; p.1118]

Uncharacteristically (contradictory at least to his philosophical stance per his famous *Meditations*) and despite his otherwise humane social policies, apparently noting something ominous in Christianity, he continued the persecution.



“The Epicurean gospel,” says R.E.Latham in the introduction to his translation of the epic poem *De rerum natura* of **Lucretius** [c.95-55 B.C.]:

...was spread by zealous missionaries throughout the Greek world, and a century or so after the Master’s death it was preached within the walls of all-conquering Rome (175 B.C.). The Roman aristocracy, whose system was founded on authority and tradition, expelled these first apostles as dangerously subversive. But a century later, with the spread of Greek culture and the decay of traditional standards among the educated classes at Rome, the new doctrine had made many converts. In particular, it impinged with all the force of a divine revelation on the sensitive soul of one Roman citizen, by name Titus Lucretius Carus, who happened also to be one of the world’s supremely great poets.



[Lucretius: THE NATURE OF THE UNIVERSE;  
R.E.Latham, trans.; Penguin Classics; p.7-8]

His amazing poem presents perhaps the most advanced and complete ancient version of an a-theological cosmic view: an infinite universe with discussion of evolution, atomic theory, matter and space, meteorology, celestial phenomena, emergence of life and mind, the senses, development of language, law and government, even hints of a social contract—all of it based entirely on nature and probability given an eternity of atoms in an otherwise infinite void—and all in verse. The work is founded squarely on the Greek Epicurus and his forerunners in the atomic concept of reality, Leucippus and Democritus. Despite his calling upon Venus to help him in his task (and the mention here and there of various pagan deities), he relegates the gods to

obscurity and harmlessness; not by denying them exactly, but by placing them in another dimension whereby interaction between them and the world is not possible.

Open discussion at this point concerning Lucretius' THE NATURE OF THE UNIVERSE; R.E.Latham, trans.; Penguin Classics, 1951 (Book V, 'Cosmology and Sociology;' pp.171-216; based on reading of material handed out in last class session.

We find nothing further along these lines until the scientific revolution in thought that came about during the Renaissance. Incredible as it may seem to us, Lucretius was practically forgotten as Rome declined and the empire merged into the papacy. “From the collapse of classical civilization,” Latham relates, “only one battered manuscript of the poem was preserved to form the basis of all existing copies.” Science in the Empire had long been commandeered by engineering and the military. What remained of philosophy—especially such as these Epicurean ideas—was scorned by the rising Church. Reason was eventually enslaved by revelation and philosophy (slowly rediscovered) was made the handmaiden of theology.

One more Hellenistic figure of immense, culture-shaping importance needs mentioning before we discuss the influence of Western Christianity on how the Universe was to be perceived. The Alexandrian based mathematician and geographer, Ptolemy,

**Claudius Ptolemaeus**  
[90-168 A.D.]

was to have the greatest influence of any single astronomer on the minds of men, at least until Galileo pointed his telescope heavenward and, with Kepler lent support to the Copernican view. The *Ptolemaic system* was not revolutionary. It was mostly borrowed from Aristotle's concentric spheres (in turn based generally on Eudoxus) with some fine tuning of the epicycles to better account for the phenomena. Ptolemy's calculations were, for the most part, refinements of previous ones, for greater accuracy in predictions and calendar intercalation. His best known work is the fabulous *ALMAGEST* in which he describes his geocentric model of the Universe.



For all its inaccuracy regarding cosmic reality, it was remarkably accurate in prediction and served civilization quite well for hundreds of years—well beyond the so called *Copernican revolution* and Kepler's laws. I was in general use for many years after Galileo wrote his treatises on sun spots, assigned responsibility for the tides to the moon, discovered new moons orbiting Mars and Jupiter, and proclaimed an infinite cosmos. Forced by the Inquisition to recant his espousal of the heliocentric universe, the known world would remain, beyond Galileo—even for a time beyond Newton, under the Ptolemaic spell.

No less enduring was his *GEOGRAPHY* (translated into Arabic in the 9<sup>th</sup> century), wherein he presents a map of the world that served longer than any other ever made. Perhaps even greater in overall influence, certainly more durable, was his astrological work, *TETRABIBLOS*, (4 books, which also came to the West via the Arabs), an amazing compilation of astrology, which he considered a companion work to *ALMAGEST*.

The cumbersome and erroneous but eminently practical Ptolemaic cosmos, then—along with its star catalogue, a remarkable map of the world, his meticulously worked out astrology, supported by Aristotle's faulty and limiting physics—pretended to be bedrock for Western science—and succeeded in that claim for the next twelve to fifteen centuries.

*Why?* Think about that and we will discuss answers in our next session.

For an animated version of the Ptolemaic cosmos, go to:  
<http://astro.unl.edu/naap/ssm/animations/ptolemaic.swf>