5.
THE GREAT CHAIN OF BEING
Anaximenes and the Milesian Synthesis

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ABSTRACT:
This essay explores the suitability of ***Aer*** (THE TRIAD) as an ***arche*** in the Presocratic ***kosmos***. We examine the continuity of Anaximenes' *cosmology* with that of Anaximander, concerning such topics as the *vortex*, the doctrine of *innumerable worlds*, and musical *meteorology*. We look at his concept of *rarefaction and condensation*, its relation to *hot and cold*, and its relevance for understanding the musical architecture of the ***kosmos***. His *astronomy* and *cosmogony* are investigated. In relation to THE TRIAD, we explore more deeply the connections between *temperament*, 3-Limit harmony, and the ***apeirous*** *circles* of fifths. The historical musicological issue of *divisive vs. cyclical tunings* is discussed. We inquire into the meanings of the terms **air**, *wind*, *breath*, and *soul*. The *microcosm* is related to the *macrocosm*. Aspects of the *void* as non-being are clarified, along with the influential notion of *Soul* and macrocosmically the *World-soul*. Finally, we summarize the importance of the Milesians in Greek philosophy.

'all things are linked together, and connected with one another
in a chain extending from the lowest to the highest;
so that we see that they are not many, or rather,
that all are one.'
-Hermetica, *Asclepius* 14a (Scott, p. 327)

'To the man who pursues his studies in the proper way,
all geometric constructions, all systems of numbers,
all duly constituted melodic progressions,
the single ordered scheme of all celestial revolutions,
should disclose themselves...by the revelation of a single bond
of natural interconnection.'
-(Pseudo) Plato *Epinomis* 991e

'The god [*Demiurgos*], *however, gave priority and seniority to the soul,*
both in its coming to be and in the degree of its excellance.'
-Plato *Timaeus* 34c

HIS DATE, LIFE, AND WRITINGS

Anaximenes, the last and most influential of the three great Milesian cosmologists, was certainly a younger contemporary of Anaximander. According to Theophrastus (*Phys. Op.* fr. 2) he was his *'associate,'* probably implying that he was also his pupil and/or successor. We can be sure that he flourished around the mid-century, but his exact dates are less certain than those of Thales and Anaximander. The Succession-writers conveniently established him in the next philosophical generation after Anaximander, choosing a suitable epoch-year for his *acme*, i.e. when he was forty. According to Apollodorus, our main source for the successions, the suitable epoch-year was (again) the

capture of Sardis by Cyrus (546/5 B.C.).[1] This puts his birth around the *acme* of Thales, which is around 588 B.C. Then his *acme* sits around the death of Thales and Anaximander, and his own death at the conventional age of 60 occurs in Ol. 63 (528/525 B.C.). Also conveniently, this date sits around the *acme* of Pythagoras and Xenophanes, the up-coming generation of philosophers. This reckoning would make him maybe 24 years younger than Anaximander. It also fulfills the conventional tradition that the Milesian school lasted for three generations.

Now these dates are so neat and tidy that they must be mostly hypothetical and not exact. Yet they do give us a good indication of the *place* of Anaximenes in ancient philosophy. For he was a 'bridge' between the radical Anaximander and the more conservative Pythagoras. His influence on Pythagoras and others was enormous. It was through Anaximenes that most of the Anaximandrean concepts were disseminated throughout the Presocratic movement. Whenever later generations refered to the Milesian school, it was specifically to Anaximenes that they turned. Clearly, his philosophy was the most developed and explicit version of the framework already seen in Anaximander and (probably) Thales. The Milesian school was always associated with the sixth century, and it is not likely that Anaximenes' life continued into the fifth century. Indeed, due to political intrigues, Miletus itself was largely destroyed in 494 B.C., and never recovered to its former size and influence.

According to an unprovable tradition, one more major philosopher came from Miletus, the shadowy fifth century initiator of the atomist movement, Leucippus. Whether or not this account is true, we can rightfully claim that with the death of Anaximenes the importance of Miletus as a center of philosophy ended. The two up-coming generations of sixth century philosophers came from nearby Ionian cities, notably Colophon for Xenophanes, Ephesus for Heraclitus, and the nearby island of Samos for Pythagoras. We should emphasize that all these centers were geographically close to each other. Later, in the fifth century, we have more prominant Ionian philosophers: Anaxagoras of Clazomenae, Melissus of Samos, and Democritus of Abdera. Empedocles and Parmenides, although they were from the west, also spoke the Ionian dialect. Miletus had so many trading links with the rest of the Mediterranean and beyond that inevitably Milesian ideas had traveled far and wide.

Practically nothing is known about the life of Anaximenes. One incident is noted by Pliny,[2] that Anaximenes invented the ***gnomon*** and demonstrated it in Sparta. However, Pliny was quite unreliable as a witness of early astronomy, and he may have made it up just to associate Anaximenes with the other early sixth century astronomers. We have already seen the ubiquitious ***gnomon*** connected to every early philosopher. Yet we can be certain that Anaximenes *did* have an interest in astronomy, and all else that the ***gnomon*** implies.

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[1] This is Ol. 58, 3. Hippolytus gave Ol. 58, 1 (*Ref.* 1, 7, 9, DK 13A7) followed by the Suda.
[2] Pliny *N.H.* II, 187 (DK 13A14a).

Anaximenes' book *On Nature* was highly prized and influential, and it was copied and re-copied well into the Hellenistic era. Indeed, it may have survived (at least parts of it) into the Alexandrian era. Theophrastus (around 300 B.C.) certainly had a copy, and commented on his straight-forward and clear prose, contrasting it with the rather poetical (and problematic) expression of Anaximander. From Theophrastus, Diogenes Laertius made this brief summary of Anaximenes:[3] *'Anaximenes son of Eurystratus, of Miletus, was a pupil of Anaximander; some say he was also a pupil of Parmenides. He said that the material principle was* ***air*** *and the* ***infinite****; and that the* ***stars*** *move, not under the* ***earth****, but round it. He used simple and economical Ionic speech. He was active, according to what Apollodorus says, around the time of the capture of Sardis, and died in the 63rd Olympiad.'*

Diogenes Laertius was generally a superficial commentator on the Presocratics, and sometimes he had his facts wrong. In this instance, Anaximenes could not have been a pupil of Parmenides, who lived in the second generation following (or perhaps later, Parmenides is another philosopher for whom dates are somewhat uncertain). Parmenides and Heraclitus are more properly connected with the 'enhanced' radicalism of Xenophanes than the somewhat 'softened' radicalism of Anaximenes. Nevertheless, Anaximenes stands behind all of these philosophers.

Anaximenes re-expressed the philosophy of Anaximander in a more lucid and direct manner, and probably he was slightly more conservative in his orientation. As to his prose being 'unpoetical,' that is another unresolvable matter. The few similes that can be reliably traced to Anaximenes are all highly colorful and imaginative, like the similes of Anaximander. According to some modern sources, Anaximenes' prose style indicated that he was more 'rational and scientific' than Anaximander, but this theory is quite untenable. His philosophy was just as compatible with religious Orphism as that of his great predeccessor. It is thus quite difficult to sort out which aspects of his system were original to him, and which aspects came from his master Anaximander. We must treat them as a pair whose overall outlook is essentially the same.

ANAXIMENES' RETRENCHMENT

Most modern scholars are somewhat disappointed in Anaximenes. They see him as a figure of lesser brilliance than Anaximander, whose bold and imaginative insights constituted a great leap forward. Anaximenes appears to take a retrogressive step backwards toward a 'cruder' system. Specifically, Anaximander showed that no specific Element could be the ***arche***, it must be the 'indefinite' ***apeiron***. Anaximenes went back to using a definite form of 'matter' as his 'material *substance*.' How does he overcome the Anaximandrean arguments against using **air** or **water** as a substrate? The question was posed thus by Guthrie:[4] *'...if there is a single primary substance at all it must be a more primitive, a neutral and no longer perceptible state of things, from which all alike had*

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[3] Diogenes Laertius II, 3.
[4] Guthrie *op. cit.* p. 116.

Yet we must ask ourselves this question: why include these other descriptive terms when the four Elements are sufficient? In addition, he does makes a real *distinction* between **air** and *wind*, since the latter is somewhat more *condensed*. Similarly, **water** is denser than *cloud*, and *stones* denser than **earth**. Hence he is *not* actually defending the four discrete Elements in his cosmology. Rather, he is trying to express a *continuum* of elements between the polarity of **Heaven** and **Earth**. One Element transforms into another through the mechanism of *felting*, which can be observed as the process of *rarefaction* and *condensation*. The order of the elements *fire*, *air*, *wind*, *cloud*, *water*, *earth*, *stones* displays a definite 'flow' between two polar extremes, the original *opposites*-- *hot* and *cold*. The most primeval state of the ***kosmos*** exists when the Elements are '*most equable*'(the equivalent of ***Okeanos*** as the pre-existent *Silence*). Thereafter, a *polarity* (hot and cold, dry and wet) is established through '*movement*.'Once a polarity is birthed, then the Elements of the *vortex*, **air** and **water**, may spin out their matrix of diversity. Hence he was defending and describing the cosmology of Anaximander, who said that transformative change comes about through the *eternal motion*.

The different Elements then represent 'phase-changes' of a single underlying Element which is really a '*quasi-element*' or abstract representative of the traditional elements-in-general. Any of the traditional Elements could serve as a candidate for this position, but the most suitable are the Elements of **apeirous** diversity: **air** and **water**. Perhaps Thales intended **water** to have a similar meaning, but **air** is the best choice for various musical reasons. In Anaximander's cosmological '*egg*,' **air** sat in the medial position between the 'hot-dry' periphery circle and the 'cold-moist' center. Then again, if the Elements are only 'phases' of a single underlying 'reality,' then it is just as correct to call it **water** or **earth** or *stones* as it is to call it **air**, since they amount to the same thing. In this way, the traditional Elements were to be transcended or re-formulated in order to comprehend the infinite possibilities within a *continuum*. Thus we see here another clear expression of Anaximander's radicalism. Yet it is somewhat 'softened' because Anaximenes is willing to 'image' this continuum through the old digital language of the primary Elements and their compounds.

Appropriately enough, he chose the Element which is most 'flexible' in its variety of representations. For **air** was often connected with many related cosmological images: *aither*, *wind*, *breath*, *mist*, *cloud*, *soul*, and the *void*. He could not have made a better choice for a 'quasi-element.' Simplicius was certainly correct when he stated that Anaximenes posited **air** as an ***arche*** because[8] *'the **air** better than anything else lends itself to variations.'* It is the Element of swift transportation to the farthest reaches.

The mainstream of modern scholarship has had many problems with these fragments. First of all, the four Elements were not to be 'discovered' until the fifth century work of Empedocles. How can we account for them here? One popular method among academics, serving to negate the evidence, is simply to blame Theophrastus (the fountain-head of the doxography) for reading into Anaximenes the later theory of the four Elements

[8] Simplicius, *de caelo* 615.188ff.

as 'simple bodies.' Unfortunately, they must also find a way to neutralize the evidence of the Elements in Heraclitus, Xenophanes, and Parmenides. The whole theory is untenable, and the Elements were surely known long before Empedocles.

Guthrie's solution is to state that the Elements *were* present in the sixth century, only they were[9] *'not yet consciously articulated. It* [the theory of the Elements] *was called forth by the criticism of Parmenides and resulted from a deliberate abandonment of the monistic position.'* He admitted that the four Elements could not be a 'sudden' invention, and they *were* implied in the *opposites* of Anaximander: hot and cold, dry and wet. But these philosophies were still 'crude' or 'primitive,' and the Elements were as yet only vaguely formulated. According to Guthrie:[10] *'When the inconsistencies of the monistic hypothesis became too obvious to be ignored, the fourfold scheme by which Empedocles replaced it lay almost ready to his hand in the systems of his predecessors, requiring only to be clarified and raised to the position of an ultimate.'* This theory is a variant of the dubious hypothesis which distinguishes 'popular' from 'philosophical' conceptions of the Elements.

Other scholars have had similar problems. Cherniss, speaking of Anaximander, said:[11] *'Neither his "contraries" nor those of any of the Presocratics were a single set of opposed agencies but an indefinite number of physical ingredients.'* His confusion is evident. Kahn (*Anaximander*, 133ff.) took solace in the fact that *'the tetrad was not yet exclusive.'* Since the Elements were not yet specifically *four*, they were not yet bona-fide Elements. Like most scholars, he also tended to confuse the Elements and the *opposites*. Everyone takes the position that the difficulties must stem from the fact that Anaximenes' philosophy was as yet undeveloped.

Another modern cunundrum stems from Theophrastus' statement that *'the other things arise from these.'* It appears that Anaximenes did not think of every kind of '*substance*' as a direct modification of **air**, but rather that there were certain basic forms (*fire, air, wind, cloud, water, earth, stones*) from which other 'kinds' were *compounded*. Hence, it was a two-tier system, like that of Empedocles: the Elements were primary, and everything else was a *product* of these--in Anaximenes' terms, an '*offspring*.' The source musical meaning of this doctrine is obvious, but it raises many difficulties for those who believe that:[12] *There is no other evidence that anyone before Empedocles tried to give a detailed account of any but the main cosmic substances; having invented a device to explain diversity, it would be more in the Milesian character for Anaximenes to have adhered to it; and Theophrastus was prone to add just such generalizing summaries, often slightly misleading, to a specific list.'* Kirk stated that, having found the mechanism by which everything could arise from **air**, Anaximenes had no need and no inclination to posit the other Elements as intermediaries. Consequently he attempted to undermine the

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[9] Guthrie, *op. cit.* p. 122.
[10] *Ibid.*, p. 123.
[11] Cherniss, *ACP*, 55.
[12] Kirk, Raven, and schofield, *op. cit.* p. 148.

authenticity of the two fragments; inevitably they must have been contaminated by Theophrastean projections. In this manner, modern interpreters have managed to deny the very core of Anaximenes' philosophy to him.

But the clear evidence of these two key fragments is supported by another ancient passage from Cicero:[13] *'After Anaximander his pupil Anaximenes postulated* ***infinite air****, the* ***products*** *of which are however determined. These are* ***earth****,* ***water*** *and* ***fire****, and from them comes everything else.'* Again we see multiple stages. First, the '*offspring*' of **air** are the other Elements. Then their '*offspring*' consist of '*the rest.*' We cannot escape the conclusion that Anaximenes accepted the four Elements and their products within his image language, but only as the 'phases' of an all-inclusive 'super-element' (***Aer***) which could account for the continuum. He then 'softens the blow' of his radicalism by allowing the digital imagery of 'primary' and 'compound.' In this way, his cosmology had great flexibility and attracted many followers.

RAREFACTION AND CONDENSATION

The concept of '*rarity and density*' is obviously central to Anaximenes' cosmology. It is the process or mechanism whereby the transformation of the ***Aer*** is maintained. We have already indicated in the last essay, that it should be interpreted as yet another expression of the primary *opposites*--hot and cold, or dry and wet. Anaximenes conceived of the cosmos as the offspring of a generative *polarity*. The metaphorical imagery used shows that it evolved out of the old mythological polarity of **Heaven** and **Earth**. Even though Anaximenes still used the terminology of the traditional discrete Elements, his desire (like Anaximander) was to model a continuum or 'flow' between the extremes. Hence, from a radical perspective, the conception of the more 'analog' *opposites* tends to 'side-step' or replace the traditional 'digital' Elements.

Although we can equate '*hot and cold*' with '*rarity and density*,' the latter expression has a certain lucid refinement beyond the simple polarity of '*hot and cold*,' or '*dry and wet*,' or '*light and dark.*' It points more transparently to underlying musical verities. Like Anaximander's fragment concerning *Time*, this doctrine has a number of musical associations or contexts, demonstrating the advanced musical sophistication of his imagery. First of all, one can observe that the fret-boards of tempered systems all display a pattern in which the 'density' (due to the distances between the frets) increases as one moves 'up' the neck (from **Heaven** to **Earth** in the old monochord symbolism). One can observe this on a modern guitar or any other fretted instrument. Classical monochords used only two octaves, but it was recognized that one could carry on indefinitely dividing the string in half. As one approaches the bridge of the music wire, the density becomes '*infinite*;' indeed, as long as one continues to divide the remaining length in half one *cannot* ever reach the end. This musical issue was the subject of Zeno's paradoxes, but the awareness of the problem was already evident in Parmenides and Xenophanes. Suffice it to say here that the concept of '*rarity* and *density*' has a direct empirical application to

[13] Cicero, *Acad. pr.* II, 37, 118, (DK 13A9).

monochord work, and it is accurately descriptive of the architecture of a divided music wire, whether that division be traditional or tempered.

Another example of the suitability of '*rarity and density*' to the musical context involves the concept of *resolution* within tempered systems of harmony. A highly resolved system like 53-et, which has many tones or 'positions' (***loci***) between the octave, is appropriately described as more 'dense' in comparison to a more shallow 'rare' resolution, such as 12-et. Again, we see a clear *consistency* between the descriptive language and a musical framework of understanding. It shows that not only did Anaximenes have a good grasp of musical architecture, but also that he was willing to extrapolate its features in order to conceptualize the universe at large.

The standard modern interpretation of Anaximenes has latched onto '*rarefaction and condensation*' as the aspect of his cosmology which proves that he was 'scientific,' and to justify the notion that he *did* make some progress over Anaximander. For example, Burnet wrote:[14] *'At first, this looks like a falling off from the more refined doctrine of Anaximander to a cruder view; but this is not really the case. On the contrary, the introduction of rarefaction and consensation into the theory is a notable advance. In fact, it makes the Milesian cosmology consistent for the first time; since a theory which explains everything as a form of a single substance is clearly bound to regard all differences as* ***quantitative****. The only way to save the unity of the primary substance is to say that all diversities are due to the presence of more or less of it in a given space. And when once this step has been taken, it is no longer necessary to make the primary substance something "distinct from the elements," to use Aristotle's inaccurate but convenient phrase; it may just as well be one of them.'* Other scholars as well have praised Anaximenes for reducing apparent differences of kind or *quality* (attributes) to a common origin in differences of *quantity*. Since true science is quite dependant upon mathematics, he must be interpreted as taking an 'essential first step' toward modern science.

Yet this argument is deeply flawed, since it assumes that before Anaximenes no one had ever made any connection between *quality* and *quantity* in the cosmos. This isomorphism is the very feature of monochord work which is most striking. Every musical interval which is experienced qualitatively has some quantitative essence in its associated ratio. It is difficult to believe that this awareness began only with Anaximenes. The parallelism between quantity and attribute was a mainstay of ancient magic.

Most modern interpreters have been somewhat ambivalent about Anaximenes' 'discovery' of the quantitative element in nature. Although they want to hail him as the initiator of this important 'discovery,' they are reluctant to concede that he had *any* knowledge of the importance of numbers as cosmological elements. For example, Guthrie wrote:[15] *'We are still at the very beginning, the first dawning of rational explanation, and*

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[14] Burnet, *op. cit.* p. 73-74.
[15] Guthrie *op. cit.* p. 126-127.

there is no question of Anaximenes having made any mathematical applications of his new principle. That advance may justly be credited to the Pythagoreans.' Apparently no one before Pythagoras was at all aware of the relevance of numbers to cosmology! These scholars forget or ignore the fact that the Orphics had a *hymn* (sacred song) to Number (inevitably lost), and that the first 60 numbers were gods for the ancient Babylonians. The modern tendancy to 'ghetto-ize' numbers only to the Pythagoreans is an insult to the other Presocratic philosophers, and a serious misrepresentation of the intentionality of their movement as a whole. The meaning of *Number* as vibratory *entity* lay at the core of their focus. In this regard, notice how well a concept of numbers (as abstract entities) blends with the notion of '*rarity and density*.' They suit each other quite well, especially within the context of monochord manipulation.

The concept of *rarefaction* and *condensation* had a profound effect on the whole of the Presocratic movement. For example, consider fragment 12 of Anaxagoras, in which he speaks of the *vortex*: *'it began to rotate in the beginning. And it began to rotate first from a small area, but now rotates over a wider and will rotate over a wider area still. ...and this rotation caused the* ***separating off****. And the* ***dense*** *is separated from the* ***rare****, the* ***hot*** *from the* ***cold****, the* ***bright*** *from the* ***dark****, and the* ***dry*** *from the* ***moist****.'* Yet most modern interpreters have done their best to confine the concept to Anaximenes. As usual, they want to isolate Anaximenes from the other philosophers, as if their cosmologies were in competition with each other.

They have been encouraged by a statement of Theophrastus to the effect that the doctrine belonged to Anaximenes *alone*. Simplicius felt compelled to correct him:[16] *'For in the case of him [Anaximenes] alone did Theophrastus in the* History *speak of rarefaction and condensation, but it is plain that the others, also, used rarity and density.'* It should be noted that Aristotle seemed to imply that his teacher Anaximander also held the doctrine. He wrote:[17] *'Two types of explanation are given by the physicists. Those who have made the subsisting body* ***one****, either one of the three* [**water**, **air**, or **fire**] *or something else which is thicker than* ***fire*** *and finer than* ***air****, generate the rest by* ***condensation*** *and* ***rarefaction****, making it into many.'* Aristotle is hinting here that not only Anaximenes (and Heraclitus) used it, but also Anaximander (supporter of the 'intermediate substance') and even Thales. Indeed, the changeable character of **water** (as ice, liquid, and gas) makes it quite suitable for such an interpretation. It would appear that the notion was basic to the Milesian cosmology.

The need to isolate and confine the doctrine to Anaximenes came from the desire to find some manner in which Anaximenes could make 'scientific progress' over the cosmology of Anaximander. Hence Anaximenes' doctrine must be separated and distinguished from that of Anaximander. In reality, the two philosophers are entirely compatible, and any difference between them must be only a slight change of emphasis.

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[16] Simplicius *in Phys.* 149, 32.
[17] Aristotle *Phys.* A4, 187a12.

FELTING

In the fragment of Hippolytus and elsewhere, the process of *rarefaction* and *condensation* is described by using the colorful simile of '*felting*' (***pilasis***). Most scholars agree that this term probably goes back to Anaximenes himself. It became a regular term for this process, used by all the early cosmologists, indeed, even by Plato. For example, here is Plato in his usual elliptical manner talking about the growth of hair on the skin of the cosmic man:[18] *'This is the process by which hair has come to **grow** on the skin. Hair is something **fibrous**, made of the same stuff as the skin, though harder and more **dense** due to the **felting** effect of the **cooling** process: once a hair **separates off** from skin, it is cooled and so gets felted together.'* Note the association of *density* with *cooling* and with the *separating off*, all terms in the Milesian cosmological language. Plato also used it elsewhere in the *Timaeus*, for example at 58b4. This dialogue, concerning the traditional cosmological doctrines, is heavily infused with Milesian ideas and terminology, although most modern scholars assume that these ideas were original to Plato.

It isn't generally recognized how very appropriate the term *felting* is as a description for the central process of the Milesian cosmogony-cosmology. The *Encyclopedia Britannica* (15th ed., s.v. felting) defines it as: '*the production of nonwoven fabric by the application of heat, moisture and mechanical action, causing the interlocking or matting of fibres.*' It is natural that Anaximenes should use such a simile, since Miletus, after all, was a famous center of the textile industry. We will see later that he also described the starry vault as a *'little felt cap.'* But its suitability goes far beyond this natural industrial source for the simile. The 'interlocking or matting of fibres' beautifully describes the cosmic matrix of interval relations or the 'harmonic being.' The process itself involves the 'application of heat, moisture, and mechanical action.' Here we have a perfect co-relation with the cosmogonical process already seen in Anaximander. The application of heat on the periphery to a moist interior generates the movement of the *vortex*, expanding the original cosmic '*egg*.' The simile is perfectly suited to the musical-cosmological context.

As usual, Kirk and his associates wanted to deny the term to Anaximenes, in their effort to portray Anaximenes as a 'naive monist.' They wrote:[19] *'the expression "felting," for the condensation of **air**, is found also in ps.-Plutarch's summary* [examined later] *and probably comes from Theophrastus; it was a common fourth-century term and need not have been used in this form by Anaximenes himself, contrary to what Diels and others say.'* This sort of argument is often used to denigrate the work of the early cosmologists. It is usually Theophrastus who is to blame for 'projecting' some doctrine onto an early philosopher, who is in reality more 'primitive' and less evolved. Unfortunately, the very suitability of the term and the sheer inner consistency of the Milesian cosmology makes it highly likely that they themselves originated it. Modern scholars tend to over-estimate the

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[18] Plato, *Timaeus* 76c.
[19] Kirk, Raven, and Schofield, *op. cit.* p. 145.

originality of Plato and Aristotle, and under-estimate the conceptual sophistication of the early philosophers.

Note that the quote from Plato clearly links *felting*, *condensation*, and *cooling*. It is obvious that *rarefaction-condensation* cannot be separated from *hot-cold* in the Milesian cosmology. Another example of this linkage can be seen in a famous fragment from Plutarch, which shows that even late in the ancient world, writers still had access to genuine citations from Anaximenes' book:[20] *'...or as Anaximenes thought of old, let us leave neither the* ***cold*** *nor the* ***hot*** *as belonging to substance, but as common dispositions of matter that supervene on changes; for he says that matter which is compressed and* ***condensed*** *is* ***cold****, while that which is fine and '****relaxed****' (using this very word) is* ***hot****. Therefore, he said, the dictum is not an unreasonable one, that man releases both warmth and cold from his mouth: for the breath is chilled by being compressed and condensed with the lips, but when the mouth is loosened the breath escapes and becomes warm through its rarity. This theory Aristotle claims to be due the the man's* [sc. Anaximenes'] *ignorance...'*

Other writers gave alternative explanations for the observation. Here is one criticism which has survived:[21] *'A person who blows out* ***air*** *does not move the* ***air*** *all at once, but blows through a narrow opening of the lips, and so he breathes out just a little* ***air*** *but moves much of the* ***air*** *outside his body, in which the warmth from his body is not apparent because of its small amount.'* The imagery initiated by the Milesians was still being actively discussed at a late date in the cosmological-medical literature.

The term '*relaxed*' or '*slack*' (***chalaros***) is definitely Anaximenean, and the whole piece came out of a commentary on a lost passage from Aristotle. Interestingly enough, the term '*slack*' (and its opposite, '*tight*') were also in common use within ancient Greek music theory. As we know from the evidence of Aristoxenus and Ptolemy, some scales were described as more '*slack*,' others as more '*intense*.' Again we see an overlap between the language of music theory and cosmological theory. Anaximenes was making a direct co-relation between variations of *hot-cold* and *rarity-density*. Surely both versions were alternative ways of expressing the same cosmic *polarity* which underlies the musical cosmos. This fragment re-inforces the fragment of Hippolytus, in which the *opposites* of *hot* and *cold* were emphasized as a vital part of 'coming-to-be' (***genesis***).

Again, Kirk and his cohorts wanted to blame Theophrastus for foisting the whole thing onto Anaximenes. We read:[22] *'It is, however, difficult to see how these opposed substances could be basic in Anaximenes' scheme of things, and it seems highly probable that Theophrastus, seeing that some prominence was given to hot and cold in Anaximenes, suggested that they were for him, as they were for Aristotle and for Theophrastus himself, one of the essential elements of* ***genesis****. (The Peripatetic simple*

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[20] Plutarch, *de prim. frig.* 7, 947f (DK 13B1).
[21] Pseudo-Aristotle, *Problems* 34.7 964a13-16, not in DK.
[22] Kirk, Raven, and Schofield, *op. cit.* p. 149.

bodies were composed of prime matter informed by either hot or cold and either wet or dry.)' Rather than using Theophrastus as the source of the connection between the *opposites* of *hot-cold* and *rarity-density*, we should recognize that these ideas were original to the Milesians themselves, and had a profound long-term influence on Greek cosmology. Thus we still see the importance of the terms in the followers of Aristotle, only now they are connected solely with physical 'substances' in a context which is less musical.

Modern interpretations are strictly literalist. For example:[23] *'But can even Anaximenes have thought that temperature varied directly with density? There is such a thing, for example, as hot stone or cold air. This difficulty might not have occurred to him...'* As usual, we see no inkling that Anaximenes could have been using metaphorical or poetical language to speak about a deeper issue than 'hot stones.' We must interpret him only as a crude but 'scientific' thinker. A similar bias surrounds the issue of the 'breath' as a 'scientific experiment.' This fragment of Plutarch is one of the first extant recorded Greek uses of a detailed observation to support a 'physical' theory. Hence many modern scholars have used it to 'prove' that Anaximenes was 'scientific.' They go on to argue over whether it was a 'true' scientific experiment or not. Some interpreters even make Anaximenes a precursor of Boyle's Law (that gases expand when heated, the basis of a modern thermometer). All of this is totally beside the point. We should look upon *rarity-density*, *hot-cold*, and *dry-wet* as equally metaphorical and colorful ways of describing the key concept of the *opposites*, a central theme in the Milesian musical cosmology.

AER AS AN *ARCHE*

The term ***Aer*** (**air**) had a number of meanings and associations, making it quite suitable for use as a flexible '*quasi-element*.' Traditionally, it signified *mist, cloud*, or *fog*, or even *darkness*. In this sense it obscured the vision and hid any objects which it surrounded. It was used in this sense by Homer, for example, where ***Zeus***[24] *'scattered the **air** and thrust aside the **mist**, and the **sun** shone out and all the battle was plain to see.'* It was used in a similar sense by Anaximander, where the ***Aer*** surrounded and concealed the wheels of **fire**. In both cases, ***Aer*** stood for the multiplicity which conceals and yet reveals the One (**fire**). When it was a bit more rarified, it became the invisible atmospheric ***Aer*** that we would normally translate as **air**. The term *wind* or *breath* (***pneuma***) stood for a similar state of the **air**. For Anaximenes it was also akin to *soul* (***psyche***). When it was rarified still more it became ***aither***, the purified **air** of the upper atmosphere adjacent to the realm of **fire**, the home of the sacred planets and stars.

The aim of the purification of the *soul* was to become 'dryer' and more like the ***aither***. In all of these images, the 'quality' of the **air** was conditional upon the amount of **water** in it. The purified and rarified **air** was 'dryer,' the denser and 'wetter' **air** was more

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[23] *Ibid.*, p. 149.
[24] Homer, *Iliad* xvii, 649.

weighed down with 'earth-directed' material. Thus Heraclitus said (fragment 118): *'A dry **soul** is wisest and best,'* and fragment 36: *'For **souls** it is death to become **water**, for **water** it is death to become **earth**; from **earth water** comes-to-be, and from **water**, **soul**.'* He is here expressing the common belief that **water** and **air** are '*exhaled*' from **earth**, and yet they are all mutable. They can be transformed one into the other. For Heraclitus, all are expressions of **fire** (the One), and the *soul* itself was more akin to **fire** than to **air**. For Anaximenes, this continuum was best described as the variability of the ***Aer***, a variability of *rarified-dense*, or *dry-wet*.

The traditional meaning of **air** and its relation to **fire** and the other Elements can still be seen in Plato. In the *Timaeus* (58b-c), he was describing the make-up of the ***kosmos***: *'Once the circumference of the universe has comprehended the [four] kinds, then, because it is round and has a natural tendency to gather in upon itself, it constricts them all and allows no empty space to be left over. This is why **fire**, more than the other three, has come to infiltrate all the others, with **air** in second place, since it is second in degree of subtlety, and so on for the rest.'* The Elements fill the whole space, and each has unique properties. **Fire** is the most rarified Element, and it infiltrates the rest (all numbers are divisible by One, and are expressions of the One). **Air** is next in the degree of its density. Then comes **water** and **earth**. Plato, in a typically Pythagorean fashion, wanted to preserve the old digital Elements. On the other hand, Anaximenes wanted to sublimate them into a 'super-element' continuum. Since ***Aer*** sits in the middle of the extremes, the rest could be expressed by the *condensation-rarefaction* of this one Element.

The suitability of ***Aer*** as an ***arche*** can also be derived from its flexibility within the realm of harmonics. ***Aer*** symbolizes the TRIAD, and by implication, the whole complex field of 3-Limit harmony. Since the 5-Limit (**water**) can be 'represented' within the 3-Limit by extending the line of fifths beyond the diatonic eight, it provides an aesthetically elegant way to conceptualize traditional harmony systems. When one examines the principal temperaments, its utility is even more enhanced, since they can all be modelled as a *circle of fifths*, or an ***apeirous** chain* of fifths. Hence it is a superior choice over **water**, as an organizer of 'musical space.' All of these factors influence the decision that ***Aer*** is the most suitable Element to be employed as a representative of 'elements-in-general.'

AER, DIVINITY, LIFE, AND SOUL

It is not surprising that for Anaximenes ***Aer*** is *infinite* (***apeiron***) and *divine* (***theion***). All of the Elements (Roots) have this status for the early philosophers. Various ancient testimonies confirm this fact, for example, the statement of Hippolytus that '*gods and things divine*' arose from **air**. Aetius wrote:[25] *'Anaximenes [says that] the **air** [is **god**]: one must understand, in the case of such descriptions, the **powers** which interpenetrate the elements or bodies.'* Some modern interpreters, attempting to undermine this fragment in the effort to show that Anaximenes was a-religious, claim that this statement is not authentic because it is overly Stoic in character. But it is entirely

[25] Aetius, 1, 7, 13.

consistent with ancient musical attitudes. The Elements stand for the *powers* which underly the vibratory realm. Another passage states:[26] *'Afterwards, Anaximenes determined that **air** is a **god**, and that it comes into being, and is measureless and **infinite** and always in **motion**; as though either formless **air** could be a **god**...or mortality did not attend upon everything that has come into being.'* This statement is also musically consistent, since the TRIAD comes into being, it is always in motion, and it is also potentially infinite in its ability to generate complexity. The innumerable harmonies that can arise out of **air** are also *gods*. This is confirmed in another late testimony:[27] *'He [Anaximander] left Anaximenes as his disciple and successor, who attributed all the causes of things to **infinite air**, and did not deny that there were **gods**, or pass them over in silence; yet he believed not that **air** was made by them, but that they arose from **air**.'*

Like Anaximander, he believed that **air** is always in motion, eternal (***aidion***), immortal (***athanaton***), and is the *source* (***arche***) of the multiplicity of being. It makes change possible, and hence it is *alive* (***psyche***, having *soul*). This doctrine was somewhat anathema to Aristotle, for whom the Elements were dead matter, and hence needed some exterior moving cause to account for motion. For the Presocratics, the Elements were 'self-caused' and 'self-moving,' consistent with the musical model. **Air** and *motion* were identified with *life* and *breath* (or *wind*, ***pneuma***). Everything which is alive breathes **air**, so that the power of life should reside in the **air** itself. This idea was not confined to Anaximenes, but to ancient beliefs in general, and not only in Greece. The Indian notion of *prana* and the Chinese *ch'i* amount to the same thing.

The equation of **air** with the *breath-soul* can already be seen in Greek mythology. For example, it was an old belief that a female could be impregnated (a new life originated) by the *wind* alone. The TRIAD is the impregnator *par excellance*. In the *Iliad* (xvi, 150), the horses of Achilles were born to their mother Podarge by the *wind* ***Zephyros***. Eggs laid by birds without sexual union were according to Aristotle (*H.A.* 559b20, 560a6) called *wind-eggs* or *Zephyr-eggs*, *'because in springtime the birds were observed to inhale the breezes.'* Within much Orphic poetry, a spark from the *Soul* of the ***kosmos*** (borne by the winds) enters into the body when the new baby breathes. These beliefs permeated the Presocratic movement. Even the late and somewhat more materialistic philosophers, such as Democritus, still believed it. For example, according to the authority of Aristotle:[28] *'In the **air** there are many of those particles which he* [Democritus] *calls **mind** and **soul**. Hence, when we breathe and the **air** enters, these enter along with it, and by their action cancel the pressure* [i.e. of the surrounding atmosphere], *thus preventing the expulsion of the **soul** which resides in the animal. This explains why **life** and death are bound up with the taking in and letting out of **breath**; for death occurs when the compression of the surrounding **air** gains the upper hand, and, the animal being unable to respire, the **air** from outside can no longer enter and counteract the compression.'*

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[26] Cicero, *de natura deorum* I, 10, 26.
[27] Augustinus, *de civ. dei* viii, 2.
[28] Aristotle, *de an.* 410b28, *de resp.* 472a8.

Anaximenes' fifth century follower Diogenes of Apollonia also associated **air** with the element of *soul* in the universe. His fragments 4 and 5 state: *'Mankind and other animals live on **air**, by breathing; and it is to them both **soul** and **mind**. The **soul** of animals is the same, namely **air** which is warmer than the **air** outside, in which we live, though much colder than that near the **sun**.' 'In my opinion that which has intelligence is what men call **air**, and by it everyone is directed* [lit. steered], *and it has power over all; for it is just this substance which I hold to be **god**.'* He used the same verb that Anaximander used for his ***apeiron***, 'steering all.' We can presume that these ideas go back at least to the Milesians and probably much earlier.

In his *Phaedrus*, Plato defended the connections between *soul*, *breath*, *life*, *the eternal motion*, ***apeiron***, and the *source* of being. The passage is also a spirited account of the traditional Orphic doctrine concerning the divinity and re-incarnation of the *soul*:[29]

*'Now we must first understand the truth about the nature of the **soul**, divine or human, by examining what it does and what is done to it. Here begins the proof:*

*Every **soul** is **immortal**. That is because whatever is **always in motion** is immortal, while what moves, and is moved by, something else stops living when it stops moving. So it is only what **moves itself** that never desists from motion, since it does not leave off being itself. In fact, this self-mover is also the **source** and **spring** of motion in everything else that moves; and a source has **no beginning**. That is because anything that has a beginning comes from some source, but there is no source for this, since a source that got its start from something else would no longer be the source. And since it cannot have a beginning, then necessarily it **cannot be destroyed**. That is because if a source were destroyed it could never get started again from anything else and nothing else could get started from it--that is, if everything gets started from a source. This then is why a self-mover is a source of motion. And that is incapable of being destroyed or starting up; otherwise all **heaven** and everything that has been started up would collapse, come to a stop, and never have cause to start moving again. But since we have found that a self-mover is immortal, we should have no qualms about declaring that this is the very **essence** and principle of a **soul**, for every bodily object that is moved from outside has no soul, while a **body** whose motion comes from within, from itself, **does** have a soul, that being the nature of a soul; and if this is so--that whatever moves itself is essentially a soul--then it follows necessarily that soul should have neither birth nor death.'*

Plato is here defending Anaximander's doctrine that the *eternal motion* is immortal, and hence divine like the gods. It is ***apeiron***. Plato, following Anaximenes and probably Anaximander through Pythagoras, equated it with *breath* and *soul*. He used essentially the same argument that Aristotle later associated with Anaximander: a source (***arche***) by definition cannot have a beginning--it is timeless, and a self-mover or first cause. In the old mythology, it was closely 'befriended' or identified with ***Eros***, the 'urge' or tendancy to actualize the ***kosmos***. In many ancient mythologies, the universe began as a 'thought' or 'desire' connected to a cosmic 'being' of pure consciousness--a

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[29] Plato, *Phaedrus* 245c-e. Translated by Alexander Nehamas and Paul Woodruff.

personification of universal *Soul*. This *Soul* was immanent in *soul*, *breath*, and **air**, and had other associations as well. It was also *life* itself, in all its complexity.

Later in this essay we will have a closer look at Plato's detailed account of the 'physiology' of the *World-soul*. Again, we will find that he had a profound debt to Anaximenes, although it was inevitably mediated by the Pythagoreans.

The close association between **air** and *soul* is also illustrated by a testimony which purports to contain an actual quote from Anaximenes. Most scholars regard it as spurious, but the ideas expressed are nevertheless entirely consistent with the Milesian cosmology. The writer, claiming to be Olympiodorus, says:[30] *'Anaximenes believes that there is a single, moving, infinite first principle of all existing things, namely* ***air****. For he says this: "****Air*** *is close to the incorporeal; and because we come into being by an outflowing of* ***air****, it is necessary for it to be both* ***infinite*** *and rich because it never gives out."'* Being infinite, it is ***apeiron***. When it is described as '*rich because it never gives out*,' the writer is using an argument that Aristotle attributed to Anaximander: it is the 'inexhaustible pool' which cannot be exhausted, the source of all being. '*We come into being by an outflowing of* ***air***' due to the equation of **air**, *breath*, *life*, and *soul*. Both **air** and **soul** are '*close to the incorporeal*' or invisible when they are in an '*equable state*,' and hence they are akin to each other. On the other side, at maximum 'density' **air** can express infinite complexity in its variety of manifestation. The inevitable analogy was drawn: that the individual *soul* was an expression of the multiplicity which is nevertheless *one* with the cosmic *Soul*.

MICROCOSM-MACROCOSM

This collusion between **air** and *soul* naturally supposes that there exists a close affinity between the divine or universal *soul* (or *mind*) and our own. According to Theophrastus, this conclusion was duly drawn by Diogenes, who said that:[31] *'the* ***air*** *within us'* is *'a small portion of the* ***god****.'* Here 'natural philosophy' was in complete agreement with Orphism. No doubt Aristophanes in the fifth century had both Orphics and the *physicoi* in mind when he satirized the 'divinities' **Air** and *Respiration*, and ridiculed the idea of a kinship between the **air** and the human mind (*Clouds*, 627, 230). Only in the later half of the fifth century did scepticism begin to arise over this religious doctrine. Plato still held the old belief that the human *soul* is a spark from the cosmic *Soul*. In the *Philebus* he wrote:[32] *'Where did they get them* [their **souls**] *from, my dear Protarchus, unless the universal body has a* ***soul****? You see, the universal body has the same features as ours, except that in its case those features are even more beautiful in every respect.'* This belief also permeated the Hermetic literature. The 'universal man' mirrors the individual man, only the universal is more perfect in its beauty and symmetry. The individual person embodies a divine (**Heavenly**) aspect as well as its *opposite*, an

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[30] Pseudo-Olympiodorus, *de arte sacra lapidis philosophorum* 25 (B3).
[31] Theophrastus, *de sensu* 42, Diog. A19.
[32] Plato, *Philebus* 30a.

(**Earthly**) aspect. This polarity was expressed in the religious domain through the gods ***Apollo*** and ***Dionysus***.

No doubt Anaximenes also believed in this cosmic analogy. We have evidence from a remarkable and important fragment of Aetius. Part of it reads as if it was intended as an actual quotation from Anaximenes, one of the few direct quotes (perhaps the only authentic one) that we have from this important philosopher:[33] *'Anaximenes son of Eurystratus, of Miletus, declared that* ***air*** *is the principle of existing things; for from it all things come-to-be and into it they are again dissolved. "As our* ***soul****," he says, "being* ***air*** *holds us together and controls us, so does* ***wind*** *[or* ***breath****] and* ***air*** *enclose the whole world." (****Air*** *and* ***wind*** *are synonymous here).'*

It is probably impossible to decide just how far this sentence preserves the actual wording of Anaximenes, but Theophrastus and his epitomizers certainly believed that it was genuine. Even if the sentence is only a paraphrase, it no doubt faithfully communicates his doctrine. There exists a long list of scholarly commentaries on its authenticity, but the majority are willing to accept it, reluctantly. Perhaps Vlastos provided the typical response:[34] *'though much of the wording of this fragment is doubtful, there is no good reason to doubt that it paraphrases an analogy drawn by Anaximenes himself.'* Often the term *breath* (***pneuma***) is brought under suspicion for having too much of a Stoic flavour. Also, many scholars wrongly presume that the term *cosmos* (***kosmos***) did not come into practice until the fifth century. Some think that it was invented by Pythagoras or fifth century Pythagoreans. (Indeed, some commentators think that almost *everything* in philosophy came from Pythagoras, and they devote little space to the 'primitive' Milesians). Some say that it was first used by Empedocles (fragment 26). The term already appeared in Heraclitus (fragment 30) but some argue that the meaning was not yet 'consolidated.' Some think the term came from Diogenes and was then projected back onto Anaximenes. Yet the term ***kosmos*** was already referred to in connection with Anaximander. We should ascribe this key term to the *whole* Presocratic movement.

Burnet commented that the fragment is [35] *'an early instance of the argument from the microcosm to the macrocosm, and so marks the beginning of an interest in physiological matters.'* Kirk and his associates followed Burnet, and represent the extreme scepticism of the modern stance:[36] *'Yet the fully developed and clear-cut use of the inference from the known microcosm, man, to the unknown macrocosm, the world as a whole, does not otherwise appear until the latter part of the fifth century, under the influence, it is thought, of the new interest in theoretical medicine at that time; it is perhaps unlikely to occur in such a plain form so early as Anaximenes.'* But the notion of the ***kosmos*** as a *universal man* was quite widespread in ancient mythological literature, not only in Greece, but also in ancient China, India, Iran, and Egypt, as we have already

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[33] Aetius, I, 3, 4, B2.
[34] Vlastos, *AJP*, 1955, 363 with n. 55.
[35] Burnet, *op. cit.* p. 75.
[36] Kirk, Raven, Schofield, *op. cit.* p. 161.

seen in the first essay. It was quite common to believe in an *isomorphism* between man, the community, and the cosmos. These scholars wore blinders when it came to non-Greek cultures, and even within Greece they preferred to postpone the 'discovery' until a later generation. Many interpreters even assume that the concept of a *World-soul* was original to Plato. Again, this stance came out of a need to justify a model of progressive evolution in Greek cosmology. We should accept that the *World-soul* was already well articulated by the Milesians.

As we have seen in the essay on Thales, the mystical concept of a *World-soul* was already implicit in passages concerning Thales. Here are two prominent examples:[37] *'And some say that it* [**soul**] *is intermingled in the* ***kosmos****, for which reason, perhaps, Thales also thought that all things are full of* ***gods****.'* Another:[38] *'Thales said that the* ***mind*** *of the world is* ***god****, and that the sum of things is* ***besouled****, and full of daimons; right through the elemental moisture there penetrates a* ***divine power*** *that moves it.'*

We should assume that this doctrine was also present in Anaximander, although no explicit fragment directly supports it. At any rate, the doctrine is entirely compatible with the cosmology of Anaximander. We can rightly conclude that the idea of a *World-soul* was common to *all* of the Milesian cosmologists, it probably pre-dated them by Orphic cosmologists, and that the doctrine was carried forward in the Presocratic movement. They tended to see the world itself as *alive*, as a kind of huge animal organism whose parts correspond with the human body and with the architecture of harmony. Just as *breath* holds together the individual human body, *cosmic breath* holds together the ***kosmos*** as a whole.

The doctrine of *microcosm-macrocosm* is entirely supported (and demonstrated) by work with a monochord. For it quickly becomes apparent that one octave can represent *any and every* octave. The octave is the 'miracle of music,' the source of the notion of cyclical identity. Hence the octave was naturally symbolized by a circle. Within the octave we see the 'house' which is the natural *place* for the measurement of the pitch continuum (the place of the sacrifice). The infinity of the whole pitch continuum is mirrored as a microcosm within a single octave. The structure within a single octave as microcosm defines the structure within the greater macrocosm of the whole pitch continuum. This great continuum was symbolically modelled as the cosmic man, his spine was the music wire, and it was divided into a number of segments corresponding to the planets, colors, stones, physiological functions and so on. These various correspondances heavily influenced early medicine, and not only in Greece.

Within the mythological literature, the *body* and the *soul* were often seen as *opposites* of each other, but reflecting the same inner architecture. This notion was also supported by monochord symbolism, through the core *polarity* between the reciprocals: the *harmonical proportion*, and the *arithmetical proportion*. All actual vibrating entities in

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[37] Aristotle, *de anima* A5, 411a7.
[38] Aetius, I, 7, 11.

our experience exhibit aspects of the *harmonic series* or some distortion of it. It naturally represents the 'body' of the vibratory ***kosmos***. But the manipulation of a monochord exhibits its mirror reflection, aspects of the *sub-harmonic series*, the invisible mirror world of '*soul*.' This is symbolically the invisible, magical realm. The two worlds relate like the two traditional musical means: the *harmonic mean* and the *arithmetic mean*. Either process generates *ratio*, the ***logos*** world of rational harmony. Among some esoteric philosophers, *soul* also represented the irrational *geometric mean*. The term *soul* can also inevitably be associated with *space* and *void*. Anaximenes naturally co-related these images with his central notion of '*rarity and density*.' As usual, the monochord can illustrate and support this influential hypothesis. In relation to this issue, it is helpful to look at his cosmogony.

COSMOGONY AND THE VOID

We have less direct information on the details of Anaximenes' cosmogony than that of Anaximander. Consequently, many scholars assume that it must be more naive, and lacks the bold imagination of his teacher. But we can interpret the evidence more sensibly by assuming that his cosmogony is essentially the same as that of Anaximander, only more refined or worked out. The reader may recall that, for Anaximander, the ***kosmos*** began as a ***gonimon*** (egg, germ, or seed--the MONAD) which then divided into the *opposites* (derived from **Heaven** and **Earth**--hot and dry, cold and wet, rarified and condensed). These primal Elements were then mediated by **air**, the first Element of the multiplicity, which caused them to expand into the Many. For Anaximander, the cosmos was surrounded by the ***apeiron***, the unspecified realm of all possibilities. In Anaximenes, this surrounding circle was described as ***apeirous air*** or ***pneuma*** (*breath*), since the TRIAD was the agency of the multiplicity. The Milesians pictured the universe as alive and breathing, consistent with the analogy of the *soul*. Consequently, the 'baby' ***kosmos*** 'began' when it took its first breath from the '*limitless* ***pneuma***' which surrounds it.

This doctrine of the 'breathing cosmos' was common among later Presocratic philosophers. It was essential to the Pythagoreans, and we should assume that Pythagoras acquired it from Anaximenes. After all, Pythagoras was only about 20 years younger than Anaximenes, and had every opportunity to meet him and study with him. In order to gain a deeper understanding of Anaximenes' cosmogony, we are justified in taking a short 'diversion' ahead to look at the standard cosmogony of the early Pythagoreans.

The Pythagoreans described the birth of the physical cosmos by using a musical (monochord) analogy involving *breath*, *number*, and the *void*. For example, Simplicius wrote:[39] '*They* [the Pythagoreans] *said that the* ***void*** *enters the cosmos as if it breathed in a sort of* ***breath*** *from that which lies outside.*' The doctrine is confirmed in other parts of the doxography. For example, Aetius:[40] '*The followers of Pythagoras say that outside the cosmos there is* ***void****, into which and out of which the cosmos* ***breathes****.*' Stobaeus,

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[39] Simplicius, *Physics* 651.26.
[40] Aetius, II, 9,1 (Dox. 338).

referring to Aristotle's lost book on the Pythagoreans, also implicated *time* in this process:[41] *'In the first book on the philosophy of Pythagoras he writes that the universe is unique, and that from the* ***infinite*** *it draws in* ***time, breath,*** *and* ***void*** *which distinguishes the places of separate things.'* These later doxographical accounts were generally derived from Aristotle directly, or indirectly via Theophrastus.

Aristotle himself presented two extremely illuminating passages on this subject, which greatly assist in our understanding of the Milesian-Pythagorean cosmogony. During a general discussion of the opinions of his predecessors on the subject of the *void*, he wrote:[42] *'The Pythagoreans also said that* ***void*** *exists, and that it enters the universe from the* ***infinite breath****, the universe being supposed to breathe in the actual* ***void****, which keeps different kinds of things apart; for they define* ***void*** *as that which* ***separates*** *and* ***divides*** *things that are next to each other. This happens first in* ***numbers****; the* ***void*** *divides their* ***nature****.'* He is even more explicit about the process in this passage:[43] *'It is absurd, too, or rather impossible, to suppose the generation of* ***numbers****, for they are eternal. Yet the question whether or not the Pythagoreans suppose it admits of no doubt. They say plainly that when the* ***unit*** *had been constructed--whether from planes or surfaces or* ***seed*** *or they cannot say what--the nearest parts of the* ***infinite*** *at once began to be drawn in and limited by the* ***limit****. However, since they are making a world and wish to be understood in a physical sense, we must examine them in that connexion and dismiss them from the present inquiry'* [*sc.* which is concerned with abstract principles]. For Aristotle, Pythagoras' cosmogony concerned *only* the physical cosmos.

The prime Elements of the world are the *prime numbers*, which the Pythagoreans also classified as *odd* and *even*, possessing ***Peras*** and ***Apeiron***, and so on. The world begins with the One, since little can be said about the pre-existent Silence. Since the physical world reflects the musical world of the monochord, the One has *magnitude*. Aristotle complained:[44] *'They suppose their* ***monads*** *to have magnitude, but how the first* ***unit*** *with magnitude was constructed they seem at a loss to explain.'* The reference to planes (surfaces), lines, and *seeds* (the point) undoubtedly points to the Pythagorean *fluxion theory* (the monochord progression point, line, surface, solid). The first *unit* is better translated as the first *Unity*, the original One. It is described as a *seed*, or ***gonimon***, in the manner of Anaximander. The number One is the *seed* of the harmonic series and its reciprocal. The One also imposes *Limit* (definition) upon the *Unlimited*. It symbolically *breathes* the *void* into itself.

By analogy, the One is the *nucleus* of the physical world. It is the 'cosmic man' who will be sacrificed (divided) in order to generate the Many (which are also One in their musical multiplicity). This 'macro-person' is comparable to the anthropomorphic Hesiodic ***Ouranos***, and is still extant in Plato's *Timaeus* and Aristotle's animate *stars*. The ancient

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[41] Stobaeus, *Ecl.* I, 18, 1c (DK, 1, 460, 3).
[42] Aristotle, *Phys.* 213b22.
[43] Aristotle, *Metaph.* 1091a12.
[44] Aristotle, *Metaph.* 1080b19.

philosophers (and not only the Pythagoreans) assumed a religious belief in the kinship of all life. Sextus wrote:[45] *'The followers of Pythagoras and Empedocles, and most of the Italian philosophers, say that there is a certain* ***community*** *uniting us not only with each other and with the* ***gods*** *but even with the brute creation. There is in fact one* ***breath*** *pervading the whole* ***cosmos*** *like* ***soul****, and uniting us with them.'* We recognize Anaximenes as a great source for this mystical doctrine, which had a significant long-term influence on ancient cosmology.

In the Pythagorean cosmogony, the *unit-seed* (***gonimon***) is sown in the *Unlimited*, and represents the first imposition of *Limit* on the cosmos. It draws in the *Unlimited* from the outside as *breath*, breathing in the *void* and assimilating it, making it conform to *limit* by giving it specifically a *musical-numerical* structure. Thus the ***Apeiron*** is described or equated with the ***pneuma***, as well as emptiness or the *void* (***kenon***). The description of the *void* separating the nature of the numbers is a direct and appropriate reference to the monochord context of this cosmogony. From the old digital model of harmony, the *void* is that which separates the numbers in the monochord scale--the spaces between the number positions, or the numbers which are prohibited from the particular imposition of *Limit* expressed by the scale. The initial *seed* is generally described as *fiery*, in conformity to traditional musical symbolism (the One, the MONAD, **fire**). The 'material' on which it feeds is the **air** or *breath*, the 'substance' which cradles or embraces the world. Some later Pythagoreans identified it with the fifth Element (***aither***).

Thus Pythagoreans largely identified *void*, *breath*, and the *Unlimited*. According to the Stobaeus fragment which defends Aristotle, they also equated or associated these terms with *time*, another indication of the musical context of these images. Only with the *movement of time* do the cosmic transformations take place. Duration was equivalent to the *Unlimited*, which was for them chaotic or at least not yet defined. When the One was established, and it was *divided* up into numerical periods (in astronomy the recurrent movement of nights, days, months, etc.--in music scales, harmonies) then *Limit* was imposed and true *time* (***chronos***) was born.

THE FIRST BREATH

The initial act of the newly-born ***kosmos*** was thus to take the first *breath*, in an analogy of animal birth. A transparent account of this doctrine was given by the early Pythagorean philosopher Philolaus. It was preserved in the extracts from the medical doxography of Aristotle's pupil Menon, found in the papyrus *Anon. Londinensis*:[46] *'Philolaus of Croton holds that our bodies are composed of the* ***hot****; for they have no share in the* ***cold****, as he reasons from considerations such as the following: the* ***sperm*** *is warm, and it is the sperm that produces the living thing; and the place in which it is deposited (i.e. the* ***womb****) is, like it, warm; and what is like something has the same* ***power*** *as that which it resembles. Since, then, the productive factor has no share in the*

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[45] Sextus, *Math.* ix, 127.
[46] Menon, *ap.* Anon. Londinensem xviii, 8, (DK 44a27).

cold, and also the place in which it is deposited has no share in the cold, clearly the living thing produced will also be of the same ***nature****. With regard to its* ***production****, he makes use of the following reasoning: immediately after its birth the living thing draws in the* ***breath*** *outside, which is* ***cold****; and then, as if of* ***necessity****, it expels it again. This* ***desire*** *for the breath outside arises in order that, as the result of the inhalation of the breath, our bodies, which are by nature too warm, may be cooled by it.'*

Note the appropriate use of the Anaximandrean terms 'hot and cold.' The familiar musical-cosmological terms *nature* (***physis***), *production* (***genesis***), *necessity* (***anangke***), and *desire* (***eros***) are also invoked. The power inherent in the *vortex*, that 'like is attracted to like' is confirmed. The sperm and womb are reminiscent of the MONAD and DYAD, but here both are hot. This imagery is consistent with the Pythagorean notion that the **fire** is present not only in **heaven** (MONAD) but also in **earth** (DYAD). In this beautiful account, the *breath* is the element of cold which accounts for the multiplicity (TRIAD). Notice how beautifully consistent this account is with the Milesian cosmogony. Only the increased emphasis that **earth** is a central **fire** is pointedly Pythagorean. The body of the 'new-born creature' immediately draws in *breath* from the outside, which is relatively cold, and then discharges it 'like an Anaximandrean debt.' In this manner, the hot and the cold are balanced or 'mixed' as *opposites*.

This 'diversion' into Pythagorean cosmogony is meant to show how very influential was the Anaximenean *breath*, and to throw light on the cosmogony of Anaximenes himself. But how much of this confluence between *void*, *breath*, *soul*, and *number* can be attributed to the Milesians, and how much is 'original' to the Pythagoreans? According to Burnet, essentially all of it came from Anaximenes:[47] *'The Pythagoreans held, he* [Aristotle] *tells us, that there was "boundless breath" outside the heavens, and that it was inhaled by the world. In substance, that is the doctrine of Anaximenes.'* However, many modern scholars want to deny a knowledge of numbers to Anaximenes. Hence they must separate the numbers from the rest of the doctrine. For example, Guthrie wrote:[48] *'The originality of Pythagoras did not lie here, but in his mathematical* ***ordering*** *of the chaotic mass of unformed* ***matter****, which for him meant not so much the imposition of numerical organization upon it as the turning of it into numbers. Numbers (as we see from Aristotle's next words in the* Physics*) are spacially extended, and the* ***void*** *keeps them apart. What keeps things apart must be* ***something****, and the only form of existence so far conceivable is bodily* ***substance****; hence it is thought of as a particularly tenuous form of* ***matter****. The unlimited, ubiquitous and animate* ***air*** *was of course a tacitly accepted inheritance rather than a concept expressly defended.'* This interpretation suffers from the prevalent modern notion that the Pythagorean '*Number*' must also be another monistic 'physical substratum' which can only be conceived in spacial (not temporal-musical) terms. Physical 'matter' must *literally* be 'numbers,' rather than just a metaphorical way of defining the underlying musical order. In

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[47] Burnet, *op. cit.* p. 108.
[48] Guthrie, *op. cit.* p. 279-80.

this way, Pythagoras' great debt to Anaximenes is belittled, and their cosmologies are artificially separated from each other.

This does not mean that the Pythagorean cosmogony (if we can talk of only one cosmogony for the whole school) is perfectly identical to the Anaximenean version. But they are essentially the same concerning *breath* and the fundamentals of cosmology. Details probably differ. In particular, Pythagoreans were more likely to specifically identify the Elements with the traditional root-numbers. Anaximenes, being more radically inclined, was more prone to generalize the Elements as aspects of infinite ***Aer***. For both Pythagoreans and for Anaximenes, the *void* was an integral aspect of musical cosmology. Anaximenes probably accepted the *void* as the *space* between his more abstract elements of harmony. The concept of '*rarity and density*' is well-suited to this notion of the *void*. In this manner, Anaximenes served as a link with the more conservative Pythagoreans. The more radical cosmologists, such as Xenophanes and Parmenides, expressly denied the existence of the *void* altogether, being more willing to explore the paradoxical implications of harmony as a truly 'full' plenum.

Anaximenes was willing to admit a 'quasi-digital' componant in his conception of the continuum. As such, he was the bridge not only for the Pythagoreans, but also the atomists. Theophrastus was right when he made Anaximenes the forerunner of atomism. According to his interpretation of Anaximenes, he could not have conceived of 'matter' as truly continuous, since there must be more or less of it in a given space (the clear implication of '*rarity and density*'). Thus, ultimately, 'matter' must be composed of *particles* which are more or less heavily concentrated. If we allow that these particles are infinitessimally small so as to well 'simulate' the continuum, then we have the basis of atomism. Atomism was thus a particular development from the Milesian cosmology. This affinity between atomism and Anaximenes probably accounts for the traditional (but unproven) story that the founder of atomism, Leucippus, came originally from Miletus. The atomists believed that the nature of the cosmic harmony is '*atoms and the void*,' and they were quite willing to generalize the atoms as more abstract entities. The Pythagoreans, on the other hand, tied their '*monads*' more closely to the traditional digital Elements.

Thus atomism was a particular 'working out' of the implications of the Milesian (especially Anaximenean) cosmology. It was one means of coming to terms with the properties of the continuum. The scale then consists of 'quasi-digital' elements (*atoms*) which have an infinite variety of 'shapes and forms,' separated by the *void*, which is equally infinitessimal in symmetry with 'the body.' Unlike the more conservative Pythagoreans, who tied the scalar elements more closely to the root numerical Elements, the atomists were willing to give them a high degree of abstraction and system-complexity. This 'emancipation' is best seen in the Aristoxenean description of the scale as abstract '*steps*' rather than numerical-ratio sequences. This cosmology was the natural outcome of the Milesian confrontation with the *plenum*. Either the *void* was to be rejected altogether, as proposed by the radical Parmenides, or it was to be preserved along with the infinitessimal *atoms*, so that the continuum could be reproduced while saving a 'quasi-

digital' componant. This more generalized conception of the scale liberates it from the traditional monochord sequences, and it also allows 'innumerable worlds' or system alternatives.

THE COSMOGONICAL EARTH

Ancient testimonials on Anaximenes' cosmogony gave much prominance to the **earth**. For example, from the *Stromateis*:[49] *'...and all things are produced by a kind of* ***condensation*** *and again* ***rarefaction****, of this* [sc. **air**]. ***Motion****, indeed, exists from everlasting; he says that when the* ***air felts****, there first of all comes into being the* ***earth****, quite flat--therefore it accordingly rides on the* ***air****; and the* ***sun*** *and the* ***moon*** *and the remaining heavenly bodies have their* ***source*** *of generation from* ***earth****. At least, he declares the* ***sun*** *to be* ***earth****, but that through the rapid motion it obtains* ***heat*** *in great sufficiency.'* At first sight this passage seems inconsistent with other versions of his cosmogony. When the **air** *felts*, it should form first *wind*, then *cloud*, then **water**, before becoming **earth** and *stones*. Here the **air** directly becomes **earth**, and the other heavenly bodies are generated from the **earth** by *exhalation*. Another passage confirms the doctrine:[50] *'The heavenly bodies have come into being from* ***earth*** *through the* [moist] ***exhalation*** *arising from it; when the exhalation is rarefied* ***fire*** *comes into being, and from* ***fire*** *raised on high the* ***stars*** *are composed. There are also earthy bodies in the region of the* ***stars****, revolving with them.'*

While there appears to be some confusion here, it is not actually the case. These fragments present the same cosmology as we saw earlier, only from a different perspective. The testimony in which the **air** *felted* to condense into **water** and **earth** described the traditional manifest layering of the polarized Presocratic cosmos--**fire**, **air**, **water**, **earth**. Here, the same cosmos is presented in its proper cosmogonical order. **Earth** (the DYAD) is logically prior to **air** (the TRIAD) and **water** (the PENTAD). The later two are generated by *exhalation* (emanation) from the DYAD, the center of the circle. This belief was quite widespread and absolutely consistent with the old musical model of the cosmos. Of course, there is still an inconsistency, since **air** should be prior to **earth** in Anaximenes' account. Perhaps **air** is given some of the properties of Thales' ***Okeanos*** or Anaximander's ***apeiron***. The important cosmogonical elements often exchanged their properties in this manner. Notice the other Anaximandrean element in the fragment--that motion is eternal. Movement (vibration) underpins the musical cosmos. Despite the confusion, which may have arisen from corruption of the sources, the cosmogony confirms the priority of the *Roots* (Elements) over their compounds (composites).

This priority of **earth** above other cosmogonical elements reminds us of Hesiod:[51] *'And* ***Gaia*** [**earth**] *first of all brought forth starry* ***Ouranos*** [**heaven**] *equal to herself, to*

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[49] Ps.-Plutarch, *Stromateis* (DK 13A6).
[50] Hippolytus, *Ref.* I, 7, 5.
[51] Hesiod, *Theogony* 124.

cover her completely round about, to be a firm seat for the blessed gods for ever.' Here we have a beautiful description of the central **earth** surrounded by the circle of the **heavens**, the 'immovable place' for the generation of diversity. The colorful image of the **earth** and heavenly bodies '*riding* (***epocheisthai***) *on the air*' is generally accepted as original to Anaximenes. On one level this statement could simply mean that the **earth** is surrounded by **air**, or also that the musical cosmos in all its complexity is comprehended by **air**. It is also a confirmation that **air** is a uniquely important componant of the *vortex*.

The statement that certain '*earthy bodies*' revolve with the other heavenly bodies is curious. The notion is supported by another passage in the doxography:[52] '*Anaximenes says that the nature of the heavenly bodies is* ***fiery****, and that they have among them certain earthy bodies that are carried round with them, being invisible.*' Modern scholars have conjectured that these 'invisible earthy bodies' were intended to explain eclipses and the phases of the moon; but according to Hippolytus (I, 8, 6; DK 59A42) Anaxagoras also believed in them. Yet through other evidence it is generally accepted that Anaxagoras knew the true cause of eclipses, so he would have no need of 'invisible bodies' for this purpose. Diogenes also believed in them, but he probably used the theory to explain the existence of meteorites. A famous one fell at Aegospotami in 467 B.C., arousing much speculative comment. According to Kirk, the 'invisible bodies' theory was projected onto Anaximenes from his follower Diogenes. On the other hand, Eudemus, in his history of astronomy (DK 13A16) assigned to Anaximenes the discovery that the moon shines by reflected light, so he would also have no need of the theory to explain lunar phases. The testimony of Eudemus itself appears to be incompatible with the common belief in the doxography (Ib., 25, 2) that the moon is *fiery*, and hence in no need of reflected light. Kirk (*op. cit.*, p. 156) contended that the idea of the moon's reflected light was a backward projection from Parmenides (DK 28A42), Empedocles, and Anaxagoras. The whole issue illustrates how difficult it is to pin down the originator of a given classical astronomical theory. It also shows how problematic many ancient doctrines become when they are only allowed a narrow, literalist interpretation.

The curious theory of 'invisible earthy bodies' has another justification; but it is not astronomical, rather musically symbolical. The other heavenly bodies refer to the 'mediated' portions of the musical scale. These elements have factors of *two* in their mathematics, since numbers must be doubled various times in order to make octave sequences on the monochord. These factors illustrate the fundamental importance of the DYAD (**earth**, the *goddess*) in monochord arithmetic. Yet they are also *invisible*--they do not alter the *pitch values* of the elements in the way that factors of *three* and *five* inevitably do. This 'invisibility' of the DYAD is the basis of cyclical invariance (or 2-Limit harmony). The idea that portions of **earth** are present within the heavenly bodies mirrors the musical 'reality' that factors of *two* are present within the scalar componants. They also remind us that the MONAD and DYAD are ubiquitous within *any* system of harmony, any form of complexity. Hence they had special status as cosmogonical elements--they form the 'principles of Number.' The first actual Number (expression of

[52] Aetius, II, 13, 10.

multiplicity) is *three* (the TRIAD, **air**). But all forms of multiplicity embody or 'surround' the DYAD, the center of the circle. Hence the **earth** is present in the heavenly bodies. This symbolism helps account for the widespread belief in 'invisible earthy bodies' among the planets. For example, Philolaus posited an invisible 'counter earth' in his cosmic system. **Earth** and **fire**, it would seem, are omnipresent within the other Elements and their compounds.

As usual, modern interpretations are purely visual-astronomical, and do not recognize the existence of an underlying musical symbolism in ancient cosmology. Consequently, they are also suspicious of such statements as: '*he declares the **sun** to be **earth**, but that through the rapid motion it obtains **heat** in great sufficiency*.' According to Kirk (*op. cit*., p. 152), the **sun** containing **earth** is a projection from Anaxagoras and/or Empedocles, and the idea that ignition comes through rapid motion (the *vortex*) is a projection from Xenophanes. Yet both notions are entirely consistent with the cosmology of the Milesians, and the ancient musically-based symbolism in general. Modern interpretations want to separate later philosophers from the Milesians and deny aspects of the cosmology to the Milesians, so that they can be portrayed as less developed. The Presocratic philosophers are painted as 'rugged individualists' whose cosmologies are in competition with each other. Even the universal Anaximandrean image of 'eternal motion' is often denied to many of the philosophers, being relegated to a projection from Theophrastus. In this way, the essential unity of the Presocratic cosmology is lost to modern understanding.

THE FLAT EARTH AND THE VORTEX

Another peculiar feature of Anaximenes' cosmology is the emphasis on a flat **earth**, along with the other heavenly bodies. The testimony from the *Stromateis* above already alluded to it. Here are a few more references:

Hippolytus (*Ref*. I, 7, 4; DK 13A7): '*The **earth** is flat, being borne upon **air**, and similarly sun, moon and the other heavenly bodies, which are all **fiery**, ride upon the **air** through their flatness.*'

Ib. 22, 1 (*Dox*. p. 352): '*It* [**earth**, **sun**] *is broad like a leaf.*'

Aetius (A20): '*Anaximenes says that it* [**earth**] *rides upon the **air** owing to its flatness.*'

Aetius III, 10, 3 (*Dox*. p. 377; DK 13A20): '*The **earth** was like a table in shape.*'

Aetius II, 22, 1 (A15): '*Anaximenes says that the **sun** is flat like a leaf.*'

Ib. 20, 2 (*Dox*. p. 348): '*The sun is **fiery**.*'

Another testimonial was given by Plato, although Anaximenes was not directly mentioned by name. Rather, he was talking about the *physicoi* in general. The context of the previous passage in his *Phaedo* referred directly to Anaxagoras, but it applies just as well to Anaximenes or Democritus. He was defending *mind* as separate from the Elements and the first cause of the 'mixing.' He criticized those who gave a first cause immanent in

the Elements themselves without a prior position for mind:[53] *'they call it a cause, thus giving it a name that does not belong to it. That is why one man surrounds the* ***earth*** *with a* ***vortex*** *to make the* ***heavens*** *keep it in place, another puts* ***air*** *underneath as a support for the* ***earth****, which is like a broad kneading-trough* [or lid].'

This doctrine of a flat **earth** is another reason that modern interpreters judge Anaximenes to be more 'primitive' than his teacher Anaximander. The notion of a spherical **earth** was at least implicit in Anaximander, even if the evidence is not conclusive. Anaximenes is quite definite about his flat **earth**, which is imaginatively described as being broad '*like a leaf*.' Presumably this image arises because leaves are easily borne by the *wind* (**air**), they '*ride the wind*' within the swirling *vortex*. But why would Anaximenes reject the abundant evidence for a spherical **earth**? The situation is made even more puzzling when we realize that Anaxagoras and Democritus also believed in this doctrine, even though the Pythagoreans had earlier 'demonstrated' the **earth** to be spherical. Why would they continue to support this 'backward' theory? This situation leads us to suspect that the reasons are more symbolical than merely physical, but the symbolism is not altogether clear.

We are given a bit more information in a passage from Aristotle:[54] *'Anaximenes, Anaxagoras and Democritus name the flatness of the* ***earth*** *as the cause of its remaining at rest. It does not cleave the* ***air*** *beneath it, but settles on it like a lid, as flat bodies to all appearances do; owing to their resistance they are not easily moved even by the* ***wind****. The* ***earth****, they say, owing to its flatness behaves in the same way in relation to the* ***air*** *immediately underneath it, which, not having sufficient room to change its place, is compressed and stays still owing to the* ***air*** *beneath it, like the* ***water*** *in* ***klepsydrai****. For this power of the* ***air*** *to bear a great weight when shut up and its motion stopped, they bring forth plenty of evidence.'*

Here we see a connection being made between the flatness of the **earth** and its place at the center of the *vortex*. Although there is no direct evidence in the fragments concerning his support for the *vortex*, we should assume that the doctrine was accepted. After all, the notion of '*rarity and density*' is well-suited to the *vortex* concept, as well as his image of the *fiery* planets 'riding' the **air** or being 'carried' by the **air** in their swirl around the **earth**. In addition to the fragments of the doxographical literature already cited, here are two more examples which strongly point to the *vortex* model, or at least are entirely compatible with it.[55] *'Anaximenes says that the heavenly bodies make their turnings [tropai] through being pushed out by* ***condensed*** *and opposing* ***air****.'* The mechanism or 'engine' of the *vortex* is the process of '*rarity and density*,' the ability of **air** to enact extreme 'mobility' in its aid of the ongoing process of 'like seeking like.' The TRIAD is the instigator of mobility, generating the *matrix-vortex* as its 'offspring.' The other passage, from Hippolytus, re-inforces the appropriateness of '*felting*' for a vortex

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[53] Plato, *Phaedo* 99b-c.
[54] Aristotle, *de caelo* 294b13 (DK 13A20).
[55] Aetius, II, 23, 1 (*Dox*. p. 352).

based model:[56] *'**Winds** are produced when **air** is condensed and rushes along under propulsion; but when it is concentrated and thickened still more, **clouds** are generated; and lastly, it turns to **water**.'* Again, the inner consistency of the evidence encourages us to connect Anaximenes (as well as Anaxagoras and Democritus more transparently) with the Anaximandrean *vortex*.

Such a model makes it relatively easy to account for the movements of the heavenly bodies through the *eternal motion* of **air**. What perhaps needs more explanation is the one exception, **earth**. Why does it alone remain at rest? Again, the *vortex* image offers a ready answer--the center of the '*eddy*' is sheltered and immovable. It is immune from change; it is cyclical identity. We would assume that the **earth's** flatness contributes in some way to its *stability* at the center, but it isn't clear exactly how. Moreover, the heavenly bodies are also flat '*like leaves*' and they are not stable, but moving. So the connection between flatness and the stability of the **earth** is not at all clear.

In addition, Aristotle's description that the **earth** somehow sits *atop* the **air** and entraps it is decidedly problematic. The **earth** like a '*lid*' encloses the **air** and keeps it from moving out of the way and letting the **earth** fall. Presumably Anaximenes is thinking of 'autumn leaves' which fall more slowly than more compact objects because of their greater wind resistance. Yet even leaves *do* fall because the **air** moves around them out of the way. The image is not entirely appropriate to the context. Moreover, Aristotle describes the situation as akin to a *klepsydra*, or water-clock. The **air** is like this **water**, trapped so that it cannot move. It is difficult to make sense of this theory, since for Anaximenes **air** is the epitome of unbounded free mobility, and it surrounds the **earth** on all sides. It is *not* trapped like the **water** in a klepsydra. The image does not sit well with the *vortex* model. Perhaps, as Kirk noted,[57] Aristotle's use of the expression '*covers the **air** like a lid*' is his own, or borrowed from Plato in the *Phaedo* passage cited above. The '*lid*' may be from a non-Anaximenean source, but even so, we expect that it should have *some* relevance to Anaximenes.

No easy answer to this problematic passage comes to mind. Yet we assume that the image of '*leaves*' itself must be Anaximenean, and must have had some connection with the placement of the *planets* and the **earth**. One suggestion is that he may have had *boats* in mind, since the image of '*leaves riding the wind*' was associated with sail-boats riding on the **water** waves in ancient literature. Here we have a connection with ancient mythology, in Greece and Egypt, which pictured the planets as boats which were carried along by the cosmic ***Okeanos***. We would associate such maritime images with Thales. A leaf *is* somewhat like a boat when it floats on the **water**. This is, of course, quite conjectural, since no ancient source directly supports the 'boats' interpretation. At any rate, the image is highly poetic, and puts a lie to the modern interpretation of Anaximenes' writing style being 'prosaic and scientific.'

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[56] Hippolytus, *Ref.* I, 7, 7 (*Dox.* p. 561).
[57] Kirk, Raven, Schofield, *op. cit.* p. 153.

One more piece of this poetic cosmology given by the doxography is the comparison of the **earth** to a broad, flat, '*table-top*.' This image can more easily be interpreted to have a speculative connection to music. For the image of a table-top was often associated in the ancient literature with an *altar* or place of *sacrifice*. It was an important aspect of magic to establish a circle and its center. In the old musical symbolism, the center (the DYAD) is the place where the One is sacrificed (divided) to become the Many. Thus this image has a more obvious connection to the musical cosmology.

AROUND THE EARTH, THE CRYSTALLINE VAULT

One aspect of Anaximenes' cosmology which distinguished him from Anaximander concerns the movement of the stars (***astra***). According to Anaximander, the heavenly bodies move in rings above and below the centrally-poised **earth**. For Anaximenes, they move not under but around the **earth**. Here are the doxographical references:

Aetius (A14): *'Anaximenes says the stars circle round the **earth**, not under it.'*
Ib. 16, 6 (*Dox*. p. 348): *'They* [stars] *do not go under the **earth**, but turn round it.'*
Hippolytus (*Ref*. I, 7, 6): *'He says that the heavenly bodies do not move under the **earth**, as others have supposed, but round it, just as if a **felt cap** turns round our head; and that the **sun** is hidden not by being under the **earth**, but through being covered by the higher parts of the **earth** and through its increased distance from us.'*

Theodoret (iv. 16) spoke of those who believe in a revolution like that of a millstone, as contrasted with one like that of a wheel. Diels (Dox. p. 46) referred these similes to Anaximenes and Anaximander respectively. A wheel turns vertically, a millstone horizontally. Theodoret probably used Aetius as his source. If Anaximenes envisaged the **earth** as supported on a sea of **air**, he may have thought that the heavenly bodies could not pass under the **earth** without disrupting its serene poise. The '*felt cap*' analogy solves this problem, and models the sky as a hemisphere. As we will see, the stars are fixed like '*nails*' to this '*cap*,' and it rotates on the axis of the celestial North Pole (the star Polaris) in a manner similar to a felt cap rotating on our head. This apt analogy would explain why the stars move in circles around Polaris, and some of them do not set. The northern part of the **earth** is tilted toward the celestial pole, or rather, the celestial pole is tilted toward the northern parts of the **earth**. This would explain why the sun, moon, and some of the stars go beneath the horizon as they revolve around the pole. This 'tilt' would be the source of calling the northern parts of the **earth** 'higher' or 'more distant.'

Miletus' latitude is 38 degrees north, the same as San Francisco. The sun's position at summer and winter solstices are 23 and one half degrees north and south of the celestial equator, respectively. This model would explain the resulting 'tilt' of the heavenly movements. It does this in a manner consistent with mythological stories. For in the Greek and Egyptian traditions, the **sun** (and presumably the other planets) float in boats (or a golden bowl) around the **earth** from the west back to the east on the celestial river ***Okeanos***. They do this in a manner similar to a cap revolving round our head. The '*felt*

cap' image is accepted as original to Anaximenes, and consistent with his image of '*felting*.' The **sun** does not go under the **earth**, but behind the '*higher parts*' to the north, in mythology, the Rhipaean mountains, or the sacred 'world mountain' to the north. These higher mountains in the north are the result of the tilting of the flat earth.

Aristotle made a commentary on this astronomical model. He did not name Anaximenes directly, but it can be inferred. The context of the passage is concerned with showing that the greatest rivers flow from the north where the mountains are higher because of the earth's tilt:[58] *'Many of the old astronomers were convinced that the* ***sun*** *is not carried under the* ***earth****, but round the* ***earth*** *and this region; and that it is obscured, and makes night, through the* ***earth*** *being high toward the north* [or toward the pole star].' Anaxagoras, Leucippus, and Diogenes expressed similar views.

Some modern interpreters have concluded that this evidence proves that Anaximenes' cosmos was hemispherical, and that he did not know about the full sphere. This seems highly unlikely, and comes from a confusion between a literal and a poetic interpretation of the evidence. Other cultures in the region (for example, Babylonia) also used the image of the **sun** going round the **earth** in a poetic manner while still being aware that the celestial vault is a sphere. Many interpretive problems come from the restriction to literalism. Heath (*Aristarchus*, p. 41) was worried that the cap must be too large in order to make it revolve round the head. Guthrie (*op. cit.* p. 138) thought the cap must be a turban, which is 'wound round the head.' (Turbans *were* common in Miletus and all of Turkey up until the recent past). He was distressed by the 'crudeness' of Anaximenes' astronomy, and took solace in the report of Hippolytus (*Ref.* I, 7, 6; DK 13A7) that according to him *'the stars give no heat owing to their great distance.'* At least he got one thing right, abandoning Anaximander's 'strange' doctrine that the stars are nearer the **earth** than the **sun**. Such interpretations assume that Anaximenes' cosmology must be strictly literalist and 'scientific,' with no poetic componant involved. The most likely story is not so simple.

Another aspect of his astronomy has provoked much comment. Anaximenes pictured the stars as fastened to the celestial vault like nails. Here is the doxographical source:[59] *'Anaximenes says that the stars are implanted like nails in the 'ice-like'* [crystalline vault]*; but some say they are fiery leaves like paintings.'* Burnet and others have suspected corruption in the source. Again we see '*fiery leaves*' connected to Anaximenes. If we presume that the '*fiery leaves*' are authentic, the rest is also likely to be so. The implication is that the celestial sphere is a solid, crystalline, 'ice-like' sphere, and that the stars form 'paintings' (constellations).

Now this appears totally compatible with the old Homeric view of the cosmos, which was likened to a solid, bronze bowl. However, many modern interpreters want to distance Anaximenes from the old mythological conceptions of the cosmos. For example,

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[58] Aristotle, *Meteor*. B1, 354a28.
[59] Aetius, II, 14, 3-4 (*Dox*. p. 344).

Kirk and his associates wrote:[60] *'...the concept of a solid outer* ***heaven*** *is foreign to the little that is known of Anaximenes' cosmogony and to the other details of his cosmology.'* Superficially, this is the case. He connected solidity with cold, rarity with heat. **Fire** is most rare, and '*rose aloft*' to become the stars on the periphery of the universe. How could this sphere of stars now become frozen solid? Guthrie wrote:[61] *'The notion of a hard, crystalline sphere or spheres, so dear to astronomers and poets of medieval and renaissance days, was a rare one in Greek thought, and where it does seem to occur is a little puzzling.'* He thinks that the notion came originally from the Arab astronomers. For Aristotle and his followers, the outer heaven was of pure, invisible **fire** or fire-like **air** (***aither***). It was still solid, but invisible like **air**. Many modern interpreters are reluctant to ascribe this theory to Anaximenes.

However, in Anaximenes' defence, later Presocratic philosophers who were greatly influenced by his astronomy also posited a solid circumference to the whole. For example, Parmenides, in his '*Way of Seeming*' poem, said:[62] *'that which surrounds his mysterious heavenly rings 'is solid like a wall, and under it comes the fiery ring.''* This 'wall' is equated with the ***aither***, when, a little later, Aetius said that:[63] *'****aither*** *is uppermost and surrounds everything.'* The ***aither*** is described as '*fiery*.' A more direct connection with Anaximenes' image of '*ice-like*' is found in the doxographical literature concerning Empedocles. Although no actual fragment from Empedocles deals with this point, Aetius again believed that **fire** itself had the power of 'freezing' or solidifying.[64] In all the idea was associated with Empedocles three times by Aetius. For example, he wrote that Empedocles said:[65] *'fixed stars were bound to the ice-like.'* Lanctantius, whose source was Varro, described Empedocles' heaven as *aerem glaciatum*.[66] Finally, the *Stromateis* (A30) said that **fire** occupies the space under the coagulation (***palos***) of **air**, a parallel to the situation of the fiery ring of Parmenides. In other words, the notion of a solid outer vault was common in the ancient world.

Kirk tried to get around this evidence by assuming that it was an Empedoclean doctrine projected back onto Anaximenes. Guthrie (*op. cit.* p. 137) had a more ingenious explanation. He suggested that the simile could be a physiological one, since, in Galen's time at least, ***alos*** (nail) was used for a spot or lump growing on the pupil of the eye, while the cornea itself was described as '*the ice-like membrane*.' This membrane was described as liquid and not solid, a '*clear moisture like that of an egg*.' ***Alos*** could also mean wart or another kind of callus. This idea would support Anaximenes' cosmology to be somewhat like that of Anaximander--the world is surrounded by the membrane of an egg. Though this explanation is very attractive, it is nevertheless most likely that Anaximenes believed in a solid surrounding 'wall' to the cosmos, a wall (or sphere) which was

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[60] Kirk, Raven, Schofield, *op. cit.* p. 155.
[61] Guthrie, *op. cit.* p. 136.
[62] Aetius II, 7, 1 (Parm. A37).
[63] *Ibid.*, II, 11, 4 (A38).
[64] *Ibid.*, II, 11, 2 (Emped. A51).
[65] *Ibid.*, II, 13 11.
[66] Lactant. *in Emped.* A51.

transparent like **air** and had properties like **fire** or ***aither***. Such a doctrine is consistent with the model of a *vortex*, which requires a restraining round 'wall' or circumference in which to work.

Heath (*Aristarchus*, p. 42) brought out a different aspect of this doctrine. He inferred that Anaximenes was the first to distinguish between the planets and the fixed stars. The stars are attached '*like nails*' to the dome of the heavens, while the planets are free to move '*like leaves in the wind*.' This interpretation assumes that no one before Anaximenes was aware that the planets move while the stars maintain their fixed patterns. This is, of course, quite absurd, and illustrates the 'blinders' under which many scholars worked early in this century, when colonialism was rife. If we may give another example of the same mind-set: One often hears it said that the British colonialist explorer Livingstone 'discovered' the Victoria Fall in Africa. But what about the people who already lived there, and, indeed, escorted him to the site? The implication is obvious, that the local people are unimportant, it was only when a European man went there that it was 'discovered.' In the same way, many scholars blandly ignore the astronomical achievements of the surrounding cultures (especially the Babylonians who made great strides) in an effort to 'prove' that the Europeans were 'first.' We must be diligent in exposing these errors. It is quite unlikely that Anaximenes was the first man to recognize that the planets move in relation to the stars.

MUSICAL METEOROLOGY

This section is really a continuation of the section by the same name in the essay concerning Anaximander. Anaximenes appears to have followed him quite closely. As usual, any distinction between astronomy and meteorology is artificial, and both are influenced by a musically based symbolism. Thus it comes as no surprise to find citations very much like the earlier passages concerning cosmogony. According to Aetius:[67] *'Anaximenes said that **clouds** occur when the **air** is further thickened; when it is compressed further, **rain** is squeezed out, and **hail** occurs when the descending **water** coalesces, **snow** when some windy portion is included together with the moisture.'* Another example:[68] *'**Hail** is produced when **water** freezes in falling; **snow**, when there is some **air** imprisoned in the **water**.'* Although he is certainly talking about weather phenomena, the language uses symbolic musical elements, and shows the attempt to describe the world in musical terms. The changing character of the multiplicity comes about through the changing relations between the Elements of diversity: **air** and **water**.

Just as Thales explained 'earthquakes' by the movement of **water**, Anaximenes also had a similar explanation for the phenomenon:[69] *'The cause of earthquakes was the dryness and moisture of the **earth**, occasioned by droughts and heavy rains respectively.'*

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[67] Aetius III, 3, 2.
[68] *Ibid.*, III, 4, 1 (*Dox.* p. 370).
[69] Ib., 15, 3 (*Dox.* p. 379).

This account was probably derived from a fuller version by Aristotle:[70] *'Anaximenes says that the **earth**, through being drenched and dried off, breaks asunder, and is shaken by the peaks that are thus broken off and fall in. Therefore earthquakes happen in periods both of **drought** and again of excessive **rains**; for in droughts, as has been said, it dries up and cracks, and being made over-moist by the **waters** it crumbles apart.'* While Thales' explanation only credited **water**, here the phenomenon arises because both **air** and **water** are out of balance--it is overly dry or wet. This account is highly musical in character. Only when there is a balance between the Elements of diversity does harmony have some stability. Any excessive proliferation of either componant leads to over complexity and hence the break-down of the harmonic order. As in the meteorological passages attributed to Anaximander, the evidence shows a high degree of sophistication concerning musical symbolism, and a confident application of its implications to the world at large.

Anaximenes also had a comment on the nature of the rainbow. According to the doxographical literature:[71] *'The rainbow is produced when the beams of the **sun** fall on thick condensed **air**. Hence the anterior part of it seems red, being burnt by the sun's rays, while the other part is dark, owing to the predominance of moisture. And he says that a rainbow is produced at night by the **moon**, but not often, because there is not constantly a full moon, and because the moon's light is weaker than that of the sun.'* In the Olympian mythology, the rainbow was the goddess ***Iris***. Here the rainbow is explained (quite appropriately) as the result of the interaction of **air**, **water**, and sunlight; but even the weaker moonlight can occasionally also cause a rainbow. The explanation is totally consonant with Anaximenes' conception of the *opposites*, which are here expressed as *dry* and *wet*, or **air** and **water**. The red end of the spectrum is more influenced by the dry, which is more under the influence of the sun's **fire**. The blue end is more akin to the influence of **water**. Thus the continuum of the colour spectrum visible in the rainbow was co-related with the musical continuum expressed as *dry-wet*. Such co-relations were the hallmark of the Milesian cosmology, which sought an integrated perspective on nature based on musical 'truths' evident through the exploration of monochord architecture.

All of this is totally compatible with the meteorology of Anaximander. Anaximenes also agreed with Anaximander's very musical explanation for lightning and thunder, adding a further comment:[72] *'Anaximenes said the same as he* [Anaximander, concerning the cause of lightning], *adding what happens in the case of **sea**, which flashes when cleft* [divided] *by oars.'* Remember that Anaximander attributed lightning to the friction caused by *wind* when it is forcibly constrained within a black (moist) *cloud*. When it breaks free, it causes the flash and the thunder. Having been temporarily prevented from seeking its 'kin' in the *vortex*, it stores 'pent up' energy which, when released, exposes the underlying **fire** (the One which was hidden in the process of ***apokrisis***--separating off). Anaximenes confirms that the same thing happens with **water** as well as **air**. When divided by oars, it

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[70] Aristotle, *Meteor*. B7, 365b6.
[71] *Schol Arat*. (*Dox*. p. 231). The source is Poseidonius, who probably used Theophrastus.
[72] Aetius III, 3, 2.

also reveals the underlying One (**fire**), which is omnipresent in musical symbolism. This beautiful simile more than any other shows the poetic nature of Anaximenes' expression. It also shows that the modern interpretation of Anaximenes, that his expression was merely prosaic and unpoetic (and hence somehow 'scientific') is not borne out by the evidence. Both Anaximander and Anaximenes were highly poetical, and their version of 'science' was quite compatible with such language.

INNUMERABLE WORLDS

We have already covered the vexed topic of 'innumerable worlds' in the essay on Anaximander. This controversy was also extended to Anaximenes. Burnet (*op. cit.* p. 78) argued that Anaximenes believed in innumerable worlds, and that his '*gods*' represented them. This would be a natural extension of the tradition that the 'innumerable worlds' were called '*gods*' by Anaximander. All of this seems reasonable enough, since the harmonic multiplicity is also at the same time a divine *unity*. All multiplicity is a multivarious expression of the underlying Oneness within harmonic being. Since ancient times long before the Presocratics, numbers were *gods* and *harmonies*. These numbers, as harmonic *archetypes*, were subject to *change*, but always retained their inherent '*power*.' Innumerable alternatives exist simultaneously and successively, but they are all One.

Modern interpreters, seeing absolutely *no* musical order in ancient cosmology, are left without any criteria for evaluating the ancient evidence. Consequently, they often base their conclusions on the statistical number of pieces of evidence in the doxographical literature. Then they accept or reject the given evidence as 'authentic' or not according to their own prejudices or pet theories, with very little understanding of the overall unity of the ancient mind-set. A popular modern approach in the academic community is to deny as much as possible to the Milesians, so that such doctrines could be 'discovered' by later, more 'evolved' philosophers. For example:[73] *'There is far less reason to assign innumerable worlds to Anaximenes than to Anaximander, from the state of the doxographical evidence; though something was probably said on the subject by Theophrastus, on the grounds that Anaximenes, too, postulated what Theophrastus considered to be an infinite originative stuff.'* Whenever possible, give them as little credit as we can. When there *is* evidence, undermine it where possible. In this way, the early philosophers can be put 'in their proper place' within philosophical history.

In defence of Anaximenes, there does exist clear evidence that he, like Anaximander, believed in 'innumerable worlds.' In the doxographical literature, Stobaeus[74] followed Theophrastus in attributing innumerable worlds to Anaximander, Anaximenes, Archelaus, Xenophanes, Diogenes, Leucippus, Democritus, and Epicurus. In addition, we have the passage from Simplicius:[75] *'All those make the one world born and destructible who say that there is always a world, yet it is not always the same but*

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[73] Kirk, Raven, Schofield, *op. cit.* p. 151.
[74] According to Aetius II, 1, 3.
[75] Simplicius, *in phys.* 1121, 12.

becoming different at different times according to certain periods of time, as Anaximenes and Heraclitus and Diogenes said, and later the Stoics.' The evidence here posits successive worlds to Anaximenes. Note the emphasis on the measurement of periods of *time*, the essence of the musical context. The use of alternative period measurements results in the production of alternative worlds. This evident musical 'truth' can be demonstrated by using a monochord. Kirk and his associates tried to undermine this evidence by pointing out that this passage is closely based on a passage from Aristotle's *de caelo* (A10, 279b12; DK 22A10); but there Empedocles, not Anaximenes, preceded Heraclitus in the wording. Hence the passage is 'contaminated.' This is a typical modern response. Instead, we would contend that the doctrine of 'innumerable worlds' was quite widespread in the Presocratic movement.

We can cite more evidence. Cicero[76] said that Anaximenes regarded **air** as a *god*, and added that it came into being, and other *gods* came into being from it and passed away during periods of time. Much the same thing was said by Hippolytus (*Ref.* I, 7, 1) and by Augustine (*de civ. d.* viii, 2). Some modern authorities attempt to undermine this evidence (and Simplicius) by claiming that it was really a Stoic doctrine projected onto Anaximenes, Heraclitus, and Diogenes. And so the argument goes on.

Suffice it to say here that the notion of 'innumerable worlds' (successive and co-existent) is entirely compatible with Milesian cosmology, and that the high level of inner consistency within the cosmology makes it quite probable that they held this doctrine. The onus on modern interpreters should be to show why the doctrine is *not* appropriate to the philosophers, rather than to assume that the doctrine is inadmissible unless proven by strict 'legalistic' means.

The modern stance comes about through a certain attitude which assumes that the Milesian philosophers *must* be 'crude' or undeveloped. As an example of this attitude, take this passage from Guthrie (*op. cit.* p. 134): *'It is arguable that Anaximenes, having advanced his single brilliant and fruitful hypothesis of condensation and rarefaction, did not pay so much attention to the detailed working-out of a system. If so, the common background of these thinkers would lead one to expect him to produce something more closely related to the mythical cosmogonies which preceded them. This is perhaps what happened.'* We would rather contend, as this essay tries to show, that he *did* work out a detailed system which was highly influential and long-lived. Anaximenean concepts are easily recognizable in his successors, for example, in the Pythagorean camp, as well as in Heraclitus, Parmenides, Anaxagoras, Empedocles, Democritus and others. His ideas also heavily influenced Plato and Aristotle. We should give Anaximenes credit where credit is due. Although he does not appear to have been so brilliant and radical as Anaximander (one of the greatest of *all* Greek philosophers), he managed to 'ground' Anaximander's radicalism in order to form a 'middle ground' of lasting value and influence. Being positioned in this 'middle ground,' he was well placed to influence both conservatives and radicals.

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[76] Cicero, *de nat. d.*, I, 26.

ANAXIMENES AND ANAXAGORAS

We have already witnessed the strong influence of Anaximenes over the Pythagoreans, especially concerning such issues as *breath*, *soul*, and the *void* within cosmogony. More influences will come to light in the essay on Pythagoras; but our main interest here has been to shed more light on Anaximenes' own thought. A similar aim motivates this section. Theophrastus maintained that Anaxagoras had belonged to the school of Anaximenes. Anaxagoras was active in the first half of the fifth century, so that he could not have met Anaximenes in person, but the many similarities in their cosmologies point to a strong influence from the Milesians. We will illustrate these similarities by making a short comparison between the two philosophers. Of course, this comparison is not exhaustive or comprehensive. Much more must be said in the essay on Anaxagoras. Instead, we will use just one passage as illustration, although it is a long passage. The text comes from Hippolytus.[77] He has conveniently divided it into a series of numbered sub-sections.

*(3) 'The **earth** is flat in shape, and remains suspended because of its size and because there is **no vacuum**. For this reason the **air** is very strong, and supports the **earth** which is borne up by it.'*

The flat **earth** is a hallmark of Anaximenes' cosmology. **Air** is strong and supports the **earth**. It remains suspended, although surrounded by **air**, partly because of its *shape*, but more importantly because of its *size*. Anaximenes had described it as '*broad like a leaf*.' We can conclude that its very size was a factor in allowing it to remain suspended, a factor not emphasized in the passages referring directly to Anaximenes.

For Anaxagoras, it also remains suspended because there is *no void*. He took on board the radicalism of Parmenides and denied the existence of the *void* altogether. Here we have a doctrine at variance with Anaximenes. Earlier, we had presumed that Anaximenes accepted the *void* in a manner somewhat like the Pythagoreans. But the Anaximenean position is quite subtle. For Anaximenes, the *void* can consistently be posited between his 'quasi-digital' elements (characterized by rarity and density), but these elements were to *simulate the continuum*. In other words, his intention was to model the *analog* continuum, even though he retained the *digital* language of Elements and compounds. He did this by re-defining the Elements as 'phase changes' of one 'super-element.' His choice of **air** as the Element is significant, since it retains many of the properties of the *void* (being invisible, omnipresent, and so on) and yet can be classed as one of the Elements; in this manner it tends to replace the *void*. Consequently, it is not such a huge step to Anaxagoras' progressive rejection of the *void*. Again we see the fertile 'middle ground' position in which Anaximenes stood, poised between the conservatives who defended the *void* along with its digital conception of harmony, and the radicals who rejected the *void* and insisted on a plenum.

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[77] Hippolytus, *Ref.* I, 8, 3 (*Dox.* p. 562). Translated by John Burnet, *op. cit.*, p. 270-1.

*(4) 'Of the moisture on the surface of the **earth**, the **sea** arose from the **waters** in the **earth** (for when these were evaporated the remainder turned salt), and from the rivers which flow into it.'*

*(5) 'Rivers take their being both from the rains and from the **waters** in the **earth**; for the **earth** is hollow and has **waters** in its cavities. And the Nile rises in summer owing to the **water** that comes down from the snows in Ethiopia.'*

These two sections are more directly influenced by Thales and Anaximander, the teachers of Anaximenes. We saw in Anaximander how the **sea** is the left-over from the *evaporation* (*exhalation, emanation*) out of the **earth**, a consistently musical image. The pairing of **earth** and **water** reminds us of Thales and his Golden-section geometry. Esoterically, they are the first Elements in the establishment of form. Thales also had a comment on the origins of the Nile. These sections illustrate that Anaximenes probably also accepted these findings from his masters.

*(6) 'The **sun** and the **moon** and all the stars are **fiery stones** carried round by the rotation of the **aether**. Under the stars are the sun and moon, and also certain bodies which revolve with them, but are **invisible** to us.'*

Here we see an affirmation of the Anaximenean notion of 'invisible earthy bodies' among the planets. The planets, being composed of composites derived from the MONAD and DYAD, have aspects of **fire** and **earth** within them. Hence they are described as *fiery stones*. The rotation of the ***aether*** is the *vortex*. Note that the classical morphology of the planetary system is here well established--the stars sit on the periphery of the 'egg,' while the planets sit closer to the **earth**. The peculiar Anaximandrean notion where the stars are closest to the **earth** is gone, and shows that it may itself have been a corruption of the evidence. The classical system of concentric rings or spheres is already evident.

*(7) 'We do not feel the heat of the stars because of the greatness of their distance from the **earth**; and, further, they are not so warm as the **sun**, because they occupy a colder region. The **moon** is below the sun, and nearer to us.'*

'Below' means closer to the central **earth**. Again, the classical planetary system is confirmed. The stars inhabit the greatest distance from the **earth**, and it is a '*colder region*' or '*ice-like*.' The statement about the heat of the stars was also attributed to Anaximenes by Hippolytus.

*(8) 'The **sun** surpasses the Peloponnesos in size. The **moon** has not a light of her own, but gets it from the sun. The course of the stars goes under the **earth**.'*

Perhaps this section is more independant from Anaximenes. Specifically, Anaximenes said that the stars go *around* the earth and not *under* it (as Anaximander said). But Anaximenes could have been expressing himself poetically, while meaning the

same thing as Anaximander. Most modern scholars credit Anaxagoras with the discovery that the moon shines by reflected light, an important componant for finding the true cause of eclipses. According to one piece of doxographical evidence, Anaximenes believed that the moon had its own light, not so strong as the sun's light. We should keep in mind, however, that Theon of Smyrna (p. 197.14; DK 13A16) claimed for Anaximenes the discovery that the moon is eclipsed by the sun, and he gave a correct account of lunar eclipses. Perhaps Anaximenes, or even Thales, already knew the true cause of eclipses.

*(9) 'The **moon** is eclipsed by the **earth** screening the sun's light from it, and sometimes, too, by the bodies below the moon coming before it. The **sun** is eclipsed at the new moon, when the moon screens it from us. Both the sun and the moon turn back in their courses owing to the repulsion of the **air**. The moon turns back frequently, because it cannot prevail over the cold.'*

Clearly, Anaxagoras knew the true cause of eclipses. Perhaps he learned it from the Milesians, the evidence is out on this one. The '*repulsion of the air*' refers to the **air** as the 'engine' of the *vortex*. Hot and cold are implicated in fueling the *vortex*.

*(10) 'Anaxagoras was the first to determine what concerns the eclipses and the illumination of the **sun** and **moon**. And he said that the moon was of **earth**, and had plains and ravines in it. The Milky Way was the reflexion of the light of the stars that were not illuminated by the sun. Shooting stars were sparks, as it were, which leapt out owing to the motion of the heavenly vault.'*

Here the discovery of eclipses is definitely connected to Anaxagoras. Shooting stars are sparks which escape from the aetherial *vortex*. The **moon**, like other heavenly bodies, contains a portion of **earth**. This section probably contains more which was original to Anaxagoras.

*(11) '**Winds** arose when the **air** was rarified by the **sun**, and when things were burned and made their way to the vault of **heaven** and were carried off. Thunder and lightning were produced by **heat** striking upon **clouds**.'*

This section is typically Anaximenean. *Wind* and other meteorological phenomena are explained by the movement of **air** in the presence of *hot* and *cold*. Anything which is made hot tends to arise toward the heavenly vault and join the *vortex*. Thunder and lightning have the same explanation that they do in Anaximenes and Anaximander.

*(12) 'Earthquakes were caused by the **air** above striking on that beneath the **earth**; for the movement of the latter caused the **earth** which **floats** on it to rock.'*

Again we see an explanation of earthquakes which is similar to that of Thales and Anaximenes. The account is here slightly refined, since it is the relation between the **air** above and below that causes the '*floating*' **earth** to shake, not the excess of **air** or **water**. This theory can be seen as a variant on the Milesian position.

The reader will appreciate how very much this cosmological account of Anaxagoras is indebted to Anaximenes and the other Milesians. Sure, aspects of it were original to Anaxagoras, but these aspects were embedded within a solidly Milesian base. We can also find Anaximenean elements in Empedocles and Democritus; but we will forego investigating these issues for now. Rather, we will give a few examples of Anaximenes' influence on the closest of his followers, Diogenes of Apollonia.

ANAXIMENES AND DIOGENES OF APOLLONIA

Diogones was a younger contemporary of Anaxagoras, perhaps about 20 years younger than him, and he lived at a time when the Presocratic movement was coming to an end (or, at least, changing its focus). He was highly eclectic, and took much from Anaxagoras and others. In spite of this eclecticism, his cosmology was solidly Anaximenean, and helps us to gain a greater understanding of Anaximenes himself. It is truly a mark of greatness that Anaximenes, very early within the Presocratic movement, could still have such a strong influence so late in the movement. It shows that Anaximenes' cosmology had achieved a beautiful balance between conservative and radical elements, a balance which allowed it to persist when many of the extreme positions of the radicals had been rejected by history. Over a century after Anaximenes' death, his ideas were still being actively championed within the movement.

Diogenes' debt to the Milesians can been seen in the summary of his cosmology given by the *Stromateis*:[78] *'Diogenes of Apollonia makes **air** the element, and holds that all things are in motion, and that there are innumerable worlds. And he describes the origin of the world thus. When the **All** moves and becomes **rare** in one place and **dense** in another, where the dense met together it formed a mass, and then the other things arose in the same way, the lightest parts occupying the highest position and producing the **sun**.'* The most interesting part of this fragment is the description of the ***apeiron*** as the *All*, a highly appropriate name from a Milesian perspective. Out of the *All* there comes movement, so that a concentration of '*rarity and density*' is set up, the cause of the rotary *vortex*. A more succinct version of the Milesian cosmogony could not be made.

Hot and cold still have their key positions:[79] *'Nothing arises from what is not nor passes away into what is not. The **earth** is round, poised in the middle, having received its shape through the revolution proceeding from the **warm** and its solidification from the **cold**.'* The first statement shows the influence of Parmenides. The **earth** is round, but it could still be flat. The rest of the fragment is very Anaximandrean, the **earth** acquiring its shape and position due to the *vortex*, which is fueled by *hot* and *cold*. The reader will appreciate the Milesian character of this passage. Even the mysterious Anaximenean 'invisible bodies' are retained:[80] *'Along with the visible heavenly bodies revolve invisible*

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[78] Plutarch *Stromateis* fr. 12.
[79] Diog. ix, 57 (R. P. 215).
[80] Ib. II, 13, 9.

stones, which for that very reason are nameless; but they often fall and are extinguished on the ***earth*** *like the* ***stone star*** *which fell down flaming at Aigospotamus.'* Clearly, the influence of Anaximenes on Diogenes was great.

Diogenes' fragments display a clear explanation and defence of some central ideas of Anaximenes. For example, here is his explanation of why **air** is chosen as the 'super-element.' It is Diogenes' fragment 2:[81] *'My view is, to sum it all up, that all things are differentiations of the same thing, and are the same thing. And this is obvious; for, if the things which are now in this world--****earth*** *and* ***water****, and* ***air*** *and* ***fire****, and the other things which we see existing in this world--if any one of these things, I say, were different from any other, different, that is, by having a* ***substance*** *peculiar to itself; and if it were not the same thing that is often changed and differentiated, then things could not in any way* ***mix*** *with one another, nor could they do one another good or harm. Neither could a plant* ***grow*** *out of the* ***earth****, nor any animal nor anything else come into being unless things were composed in such a way as to be the same. But all these things arise from the same thing; they are differentiated and take different forms at different times, and return again to the same thing* [**air**]*.'*

This reasoned argument in favour of an 'inter-element' is of great importance, since no such argument has survived from Anaximenes himself. Given that Diogenes was such a close follower of Anaximenes, it is even possible that it is a paraphrase of Anaximenes' own thinking on the subject. Of course, this cannot be proved, but it is worth consideration. Most modern scholars would dismiss this interpretation right away, since Anaximenes was supposedly blissfully ignorant concerning the four Elements. We are not ham-strung by this dubious thesis, but we will examine the argument on its own merits and ignore the issue of its possible authorship by Anaximenes. Even if it is not original to Anaximenes himself, it supports his orientation.

The argument claims that the four Elements must have something in common with each other. If each was a different '*substance*' (the term is not yet being used in a strictly Aristotelian sense), then they could not '*mix*' or influence each other. Yet they *do* mix and '*grow*,' so that they must come from the same 'essence.'

The obverse of this argument is the very stand taken by the more conservative of the Pythagoreans. In a traditional, *digital* explication of harmony, the four Elements indeed each have a unique and incommensurable relation to each other. They are *prime factors* which are totally irreducable to each other. Strictly speaking, only the MONAD (**fire**) has the ability to divide into any other Element or compound, and only the DYAD (**earth**) has the special property of cyclical invariance. The TRIAD (**air**) and the PENTAD (**water**) are strictly incommensurate with each other and with the other Elements (except, of course, the One). So it appears that Diogenes' argument is incorrect. If he asks: how do these different entities mix, the Pythagoreans also had an answer. They mix through the formation of *ratio* (***logos***), which is itself '*harmonia*.' Philolaus put it very well when he

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[81] R. P. p. 208 (*Historia Philosophiae Graecae*, Ritter and Preller, 1898) in Burnet, p. 353-4.

said that difference is a requirement for harmony itself (fagment 6): *'Things that were alike and of the same kind had no need of harmony, but those that were unlike and not of the same kind and of unequal order--it was necessary for such things to have been locked together by harmony, if they are to be held together in an ordered universe.'* Thus, from a traditional musical stand-point, Diogenes' argument does not make sense.

But now consider the need to include irrational ratios as well as traditional rational ratios. The Pythagorean philosopher may retort that this makes no difference, since it is still *Ratio*, the essence of harmony, be it just or tempered. However, serious problems arise, even if we restrict our ratios to the traditional, rational kind. Two ratios can have very different numerical properties, and yet produce practically the same sonic experience as sound. They may *appear* to be very different, but not actually be so through listening. The next section of this essay will explore these harmonic properties of ratios further, but for now it is enough to realize the worth in achieving a more generalized and abstract conception of the nature of harmony. The Milesians sought a more all-inclusive modelling of harmony which also takes in the irrational and at least approaches the continuum (the Real Number sequence). In order to do so, they had to free themselves from the 'tyranny' of the old digital monochord sequences, and express the 'material' of the musical scale in a different 'non-digital' way. We moderns are heir to this shift--we think of harmonies in terms of *type* or *genus* irrespective of their particular numerical properties. For example, the interval that we call a 'musical major third' can have a number of varieties in size and character, both just and tempered, embodying very different numerical properties; yet we still class all of them as 'major third.' We use a different criterion than just the number ratios involved (more experiential than numerical) to classify intervals.

Given this perspective, one can defend Diogenes' argument. It is highly convenient to model the scale in abstract 'steps' (tempered and/or untempered) rather than the traditional numerical sequences. On the experiential level, there *is* something in harmony which is *common* to all divergent systems--an inherent *morphology* which is truly and demonstrably 'inter-system.' According to Diogenes' argument, it is this common element which allows the divergent and seemingly incommensurable number sequences to have 'close cousins' or strong similarities to each other. By taking this stance, we can come to a deeper understanding of harmony, an understanding not bound to a particular manifestation of harmony itself. In this way, it allows the proliferation of 'innumerable worlds' under one conceptual framework within the harmonic cosmos. The Milesian elevation of ***Aer*** to the status of 'inter-element' was the necessary beginning of this quest. The *atoms* of Democritus as elements freed from the traditional digital sequences were the culmination of this search for a new basis. With atomism, the Presocratic cosmological movement came to a climax in its conceptual re-modelling of the harmonic cosmos.

Keeping in mind these issues, we can better appreciate the following two fragments of Diogenes (fragments 5 and 6). They are given here in the translation by Burnet (*op. cit.*, p. 354-5):

(5) 'And my view is, that that which has intelligence is what men call ***air****, and that all things have their course steered by it, and that it has power over all things. For this*

very thing I hold to be ***god****, and to reach everywhere, and to dispose everything, and to be in everything; and there is not anything which does not partake in it. Yet no single thing partakes in it just in the same way as another; but there are many* ***modes*** *both of* ***air*** *and of* ***intelligence*** [***nous***]. *For it undergoes many transformations, warmer and colder, drier and moister, more stable and in swifter motion, and it has many other differentiations in it, and an infinite number of colours and savours. And the* ***soul*** *of all living things is the same, namely,* ***air*** *warmer than that outside us and in which we are, but much colder than that near the sun. And this warmth is not alike in any two kinds of living creatures, nor, for the matter of that, in any two men; but it does not differ much, only so far as is compatible with their being alike. At the same time, it is not possible for any of the things which are differentiated to be exactly like one another till they all once more become the same.'*

(6) 'Since, then, differentiation is multiform, living creatures are multiform and many, and they are like one another neither in appearance nor in intelligence, because of the multitude of differentiations. At the same time, they all live, and see, and hear by the same thing, and they all have their intelligence from the same source [**air**].*'*

INTERVAL APPROXIMATIONS AND INTERVAL CHAINS

In these essays we have been presenting short tutorials on the nature of harmony, in an effort to show why it is relevant to an understanding of ancient philosophy. Here we look at musical ratios from a different perspective. If we announce that a 'musical major third interval' is equivalent to the ratio 4:5, it is not at all obvious that this is the case simply by looking at the numbers. In order to actually *know* that a 4:5 ratio has these metrical properties, we have to listen to it by applying it somehow on an instrument. In other words, the musical tuning sciences have two inter-dependant aspects, a *theoretica* based on number theory, and a *practica* based on its application.

Until recent history, there were only two means by which the *practica* could be realized. One method gave us an 'up-directed' interval, the other a 'down-directed' interval. The first approach was called the *harmonics method*. It consists of taking a music wire, then finding the 4th and 5th harmonics, and making a comparison between them. If our music wire is tuned to the pitch 'C,' then the 4th harmonic is C, and the 5th E. The interval C-E is an 'up-directed' major third. The other method was called the *monochord method*. It consists of taking a music wire and plotting the ratio on it. The method is not difficult. Assuming our string is tuned to 'C,' then the *mese* (middle of the string) is also C. Define this position as '4,' in other words, divide the string into 8 arithmetical units. Now compare the fret positions 4 and 5. In this case, we will have a 'down-directed' interval, the major third C-Ab. The two methods are reciprocals of each other, again demonstrating the inherent 'twoness' of harmonic phenomena.

Now lets take a more complicated ratio, for example, the 3-Limit ratio whose formidable numbers are 6561:8192. In this case, the harmonics method is no longer possible. We can only find the harmonics on strings, even a relatively long string, up to about the 16th harmonic. They get more and more difficult to separate after that. The

6561st harmonic is far beyond our capacity. However, the monochord method is still quite practicable, if a bit cumbersome. Define the *mese* as position 6561 in a overall division of 13122 units, then compare position 8192. In other words, monochords allow us to deal with *any* number ratio, both large and small. Of course, monochords also have certain limitations in their accuracy, which can be overcome or minimized by specific procedures, but we won't pursue them here. The point is that the monochord method allows a high development of both *theoretica* and *practica*.

Now if we want to compare the metrical properties of the two ratios 4:5 and 6561:8192 to each other, what do we do? Traditionally, we plot them both on a monochord and compare them directly. In this case, they are practically the same, in spite of the very different numbers involved. The 3-Limit complex ratio is actually only one schisma flat (or 'squeezed' or compressed) in comparison to the 5-Limit ratio 4:5. This is not at all obvious just by looking at the numbers; we need to *apply* them to make the comparison. When we do this, it confirms that they are both varieties of what we would call a 'musical major third interval.'

Actually, another 'low technology' method exists for comparing the two ratios. It involves doing a long division of each one. In this case, 5 divided by 4 is 1.25. Also, 8192 divided by 6561 is 1.2485902. We can see that they are almost the same. Such a method of comparison is now very easy in the age of pocket computers, but the ancients had to do it by the cumbersome methods of long division. It was thus no easier than plotting them on a monochord. The monochord also had the advantage of allowing the investigator to *listen* to the results, while a long division leaves it in the abstract realm of numbers. Hence the monochord method had advantages.

A monochord thus allows us to make interval comparisons, to find other ratios which serve as *approximations* of each other. We have compared two rational ratios, but it works just as well with irrational ratios. As another example of a ratio extremely close to a 4:5, take the major third found as 10 steps within the 31-et system: the ratio with the rather frightening numbers 31/10th root of 2. Making a division, it comes out to about 1.2505651, ever so slightly wide of 1.25. The amount of tempering is not even half a schisma, we have trouble hearing the difference, and the resulting monochord positions appear practically identical. Thus we say that in the 31-et system of temperament, the major third is 'practically pure.' This is not always the case in every temperament. For example, take the major third which is 4 steps in the standard modern 12-et. It is defined by the ratio 12/4th root of 2 (which equals the cube root of 2). Here we get 1.259921, an interval considerably 'stretched' in comparison to the 31-et major third. Still, we call it a major third, because it is more like a 4:5 than it is to a 5:6, a 3:4, or any other consonant ratio. We evaluate the worth of an irrational system of ratios mostly by how well they approximate simple but powerful just norms like 4:5 or 2:3. A monochord allows us to make these comparisons between alternative ratios and systems of ratios, both rational and irrational. Hence it is a useful tool for the inter-system modelling of alternatives.

If one is a bit adventurous and has investigated alternative systems, it is quite likely that this investigation would stimulate the development of an interval language which is itself somewhat 'system neutral.' We can see this development in the writings of the famous music theorist Aristoxenus (a pupil of Aristotle). He described his preferred system (72-et) in terms of 'steps' intead of traditional number sequences, in a manner which is surprisingly modern to us. We do the same in our modern western tuning system, in which we describe the octave as divided into 12 'semitone' *steps*. Such a language is eminantly suited to systems of irrational ratios. Aristoxenus was heir to the investigations of the Presocratic philosophers, who grappled with the integration of the irrational and the rational. This integration must have involved breaking the power of the traditional number sequences themselves, understanding the morphology of irrational systems, and coming to a more abstract, more universal language. These concerns are evident in the musical cosmology of Anaximenes, where the traditional musical Elements are subsumed within a conception of a higher unity--the 'super-element' or 'inter-element' ***Aer***. This particular Element was elevated in status because it is a most 'malleable' Element. Its suitability is enhanced because it is the Element most suited to form a *chain* of intervals.

Anyone who investigates irrational systems of harmony eventually arrives at a notion of *chains of musical fifths*. Other musical intervals are not so amenable to form chains. It *is* possible to make a chain of major thirds, or other intervals, but the musical fifth (ratio 2:3, the archetypal ratio of the TRIAD) is the easiest interval to accurately tune (after the unison and octave, of course). Hence it is practical to tune a line of fifths, which was notated in ancient times by a simple line of beads in the pebble arithmetic. The more curious of the cosmologists must have extended this line, just to see what they would get. As one does this, the ratio numbers involved quickly become quite huge, but the conception and method is simple enough. As one extends this line, one always gets new intervals, since powers of 2 and 3 never divide evenly into each other. However, whether we plot the values on a monochord, or just do the divisions in the abstract, one soon learns that 'near-misses' to previous values are encountered. These near misses suggest or 'point to' the good systems of temperament.

As an important example of this situation, let us examine the familiar 12-et system. When we make a long line of pure fifths, the thirteenth member forms a pitch almost identical to the starting point, only it is stretched by a small interval called a Pythagorean comma (ratio 524288:531441). In spite of the huge numbers, it is still only a comma, being 12 schismas in size (a syntonic comma, ratio 80:81, is 11 schismas in size). Because there are 12 fifths in the chain, this 'spiral' can be closed to form a circle if each fifth is 'squeezed' flat by one schisma (our modern system of temperament). We end up with a *circle* of fifths. Note that this chain only becomes a circle (or necklace) because the fifths were *tempered* and are no longer pure. A chain of pure fifths extends theoretically to infinity. The reduction of the interval system to a circle of fifths obviously has structural and theoretical advantages, and promotes this system as a practical temperament which well approximates a 3-Limit line of 12 fifths. It is also the simplist such chain to form a circle without too much temperament (tampering of the fifths). But it is not the only such circle.

An analogous situation generates 53-et. The earliest published reference to this cycle comes from ancient China, by King Fang (no royalty implied), who lived around the time of Eratosthenes (250 B.C.). The number 60 is important in ancient Chinese cosmology, and King patiently computed a chain of 60 musical fifths. He then noted that the 54th member was practically identical to the beginning of the chain. In fact, it is sharp by less than 2 schismas. If this tiny interval is divided between 53 fifths, then each fifth is flattened by such a small amount that it is well below our ability to hear pitch differences. To all intents and purposes, a chain of practically pure fifths makes a *circle* of 53 fifths. When this cycle is plotted within one octave, the step interval turns out to be a 'tempered' comma practically identical to the traditional syntonic comma encountered in 5-Limit tunings. In fact, it is a 'mean' comma about half-way in size between a Syntonic comma and a Pythagorean comma. For this reason, 53-et is a beautiful means of integrating 3-Limit and 5-Limit harmony in one 'super-system' of comma 'steps.' Note that we have here generated another alternative circle of fifths, giving us another excellant system of temperament.

We could give more examples of chains of fifths forming useful circles of fifths, but the concept should now be clear. In this procedure, we have taken the potentially infinite line of fifths, and, through varying amounts of temperament of the fifth, formed a *closed circle*, a necklace, or *cycle of fifths*, a little 'closed' universe of interval types. By nature these are irrational systems, but in the case of 53-et they approach the rational. Being circles, they also have the property of being ***apeiron***, having no boundaries. One can 'spin around them' indefinitely. Hence they have had a certain appeal to musical cosmologists, both ancient and modern.

DIVISIVE TUNINGS VERSUS CYCLICAL TUNINGS

One of the fundamental questions taxing musicologists for the last 200 years has been this: which has historical priority, divisive tunings or cyclical tunings? First we must define the terms. *Divisive tuning* is just another name for the use of a monochord to set up the scales of music. Such harmonies are presumed to be 5-Limit in the mainstream, but they could also be 3-Limit, 7-Limit or whatever. A monochord is amenable to all alternatives. *Cyclical tuning* is the method of setting up the scale by tuning a line of musical fifths and fourths. By its very nature it is strictly 3-Limit. Sometimes this method has been called the 'up and down' method, since the usual procedure is first to tune up a fifth, then down a fourth, then up a fifth, and so on as far as one wishes to take it. This procedure could theoretically be followed totally independant of a monochord and its arithmetic.

The mainstream of the musicology community associates the divisive method with ancient India, and the cyclical method with ancient China. First to ancient India. The earliest text to deal with musical procedures, the *Natyashatra*, is not very old (perhaps 200 B.C.) but it is generally accepted to report practices which are exceedingly old. This text is not very clear, and it contains several paradoxes which appear to be deliberate. In

spite of this, most musicologists admit that the writers actually knew their subject, since they promoted the *sruti* (comma) as the basic building-brick of musical scales. No monochord division, or even a mention of a monochord, is present within the text, but it includes an experiment with two *vinas*. Yet the vina, being a fretted instrument, is really an applied monochord! Hence the majority of musicologists have classified the Indian interval system as divisive. However, a minority have tried to show that the same interval system was generated by using a cyclical method to tune a long line of 22 fifths. Interestingly enough, the 22 *srutis* of the Indian classical system can be generated by either method--it hints at an integration of the two methods. This in itself indicates that the ancient Indians were quite knowledgable about the morphology of harmony.[82]

Those who favour the priority of the cyclical method often point to ancient China for support. Indeed, the earliest historical record of an ancient tuning comes from China, and it is cyclical. Sze Ma-chi'en, a historian who was contemporary with Ptolemy (150 A.D.) ascribed the mathematical formula for the 3-Limit pentatonic scale to Ling Lun, a minister or court musician under Emperor Huang-Ti, of the twenty-seventh century B.C.! If this is true, it is the earliest recorded date in the history of music theory. Of course, the date is probably somewhat exaggerated, yet the procedure is likely to be very old. It is also very interesting, since it does not even use musical strings, but rather, bamboo pipes.

The formula starts with a length of bamboo pipe (called a *lu*) arbitrarily called 81 parts. A third of these parts is then subtracted and a third of the remaining parts added, alternatively, through four computations. The result is five pipes of 81, 54, 72, 48, and 64 parts. If the first pipe (of 81 parts) were to be called 'C,' then the remaining pipes are G, D, /A, and /E. This scale is 'up-directed.' The same numbers could be applied to a monochord, using the octave division 48:96, yielding 48:54:64:72:81:96, or pitches C:\Bb:G:F:\Eb:C--here a 'down-directed' scale. Although the reported method does not use a monochord, we know that the ancient Chinese were also quite savy with monochords. In fact, the earliest published drawings of dedicated monochords (Chinese *Q'in*) also came from China. Ling Lu did not stop here with this classical scale. Apparently, he went on to generate two sets of six *lus* each, one a Pythagorean semitone (ratio 243:256) above the other. In other words, he produced a version of the so-called Pythagorean (3-Limit) chromatic (12 note) scale.

The presence of monochords in ancient China has been embarrasing for western musicologists who believe that Pythagoras invented the monochord. But even more embarrasing has been the discovery of the ratios for a bronze sculptured *q'in* from the third century B.C. It contained both 5-Limit and 7-Limit ratios, and proves that the ancient Chinese were adept *both* in divisive and cyclical methods of tuning. Thus it is difficult to defend the thesis that ancient Chinese tuning was both purely cyclical and purely 3-Limit. Like the situation in ancient India, the jury is out concerning the priority of divisive and cyclical methods of tuning.

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[82] For an in-depth review of historical interpretations of the *Natyashastra*, see my article: *The Natyashastra and Vedic Harmonics*, unpublished, available upon request.

Moving to the west, the situation is also murky. Most musicologists still believe that Pythagoras invented the monochord and discovered the very fact of the existence of musical ratios. Apparently the high and complex music cultures of Egypt, Babylonia, India, and China had no idea how to tune instruments, or at least had no conception of the *quantification* of musical intervals. This dubious thesis is probably tenaciously held in order to justify the scientific superiority of ancient Greece ('Europe') over Asia-Africa. But the monochord principle is really only the intelligent decision over fret-placement on stringed instruments. We know from much pictorial evidence that fretted instruments existed in ancient Egypt, Babylonia, India, and China. Either their frets were placed haphazardly, or some thought was given to their placement. The latter is more likely the case, since there are many clues that the ancients understood the morphology of harmony. Hence it is more likely that Pythagoras did not invent the monochord, only introduce it to Greece, just as Thales introduced Babylonian high astronomy.

In fact, it is even more likely that Pythagoras was not the first to introduce the monochord to Greece, rather, that he was a monochord 'virtuoso' and defender, whose name was thus ever-more associated with monochords. According to the orthodox interpretation of the evidence, Pythagoras' knowledge of musical ratios was quite primitive, usually confined to the ratios of the first few numbers. Yet the earliest Pythagorean philosophers whose writings survive, Philolaus and Archytas, indicate a very sophisticated understanding of harmony and monochord arithmetic. They were certainly not primitive. This sophistication is also seen in Empedocles, Plato, and others. Pythagoras was probably using the monochord as a means to defend the traditional musical cosmology.

On the question of the priority of divisive and cyclical tunings, the evidence here is also inconclusive. According to the orthodox theory, Pythagoras invented 3-Limit harmony, and had no knowledge *at all* concerning 5-Limit harmony. Yet the fragments of Philolaus and Archytas belie this thesis. According to the writings of Ptolemy, who left a valuable list of different tunings and their defenders, Archytas used 5-Limit *and* 7-Limit ratios. Plato also used 7-Limit ratios, for example, in his Magnesia 'city' division of 5040 'citizens,' a very important 7-Limit monochord division. If Pythagoras had confined himself to only 3-Limit ratios, an argument could be made that his approach was cyclical, but the evidence of later Pythagoreans and the fact that he used a monochord means that his methods were probably divisive. If his methods *were* divisive, then they need not have been restricted to the 3-Limit. Indeed, the Pythagorean reverence for the number 10 indicates that all ratios up to the index of 10 (including ratios of 7) had value for them. Also, their emblem was the Pentacle, home of the Golden-section and closely associated with 5-Limit harmony. Hence it is unlikely that Pythagorean harmony was exclusively cyclical and 3-Limit.

Perhaps it is impossible to decide whether cyclical or divisive methods have priority. But the evidence thus far presented would seem to indicate that the divisive method came first. It is historically verifiable that the cyclical method gradually replaced

the divisive method in the history of tuning culture, especially in the Near East. At the end of the ancient period, and during the middle ages, the tuning method appears to be almost exclusively cyclical, although they often used a monochord to justify the theory. 5-Limit ratios were 'simulated' through a long line of 3-Limit musical fifths. For example, the Arabic scientists Mahmoud and Abdulqadir (14th century) in Bhagdad generated a line of 17 fifths for their theory of lute tuning. Such a method, while nominally 3-Limit, preserved the 5-Limit archetypes of ancient times. Meanwhile, the western Christian Church, in an effort to stamp out pagan music culture, suppressed or ignored the 5-Limit altogether by restricting the line of fifths to eight members. Being in a position to re-write history for their own benefit, they attributed this practice to Pythagoras. Modern musicologist still believe this likely falsification of history, even if the evidence indicates that Pythagoras knew more than just the basics of 3-Limit harmony.

Divisive methods did not die out entirely during the middle ages. For example, the Arabic lutenist Zalzal (d. 720 A.D.) used ratios of the 11-Limit. But we must acknowledge the gradual supremacy of the 3-Limit cyclical method over the old divisive method which is much more naturally associated with 5-Limit harmony. Perhaps the initiation of this evolution in the west can be associated with the Milesians, and Anaximenes in particular. The elevation in status of ***Aer*** (the TRIAD) as a cosmological componant supports a 're-modelling' of harmony as a long line of musical fifths, a 'chain' harmony rather than the old 'cloth' harmony described by Pherecydes. This shift likely began with the Milesians, although it did not replace the old ways until over a thousand years later, and even then not completely. The monochord was henceforth still used to justify 3-Limit harmony, even though the cyclical method was in use.

Ever since the Christian hegemony in the west, musicologists have maintained that the ancients knew *only* 3-Limit harmony, in spite of their use of a monochord. But how likely is it that the ancient tuners knew only the 3-Limit dissonant major third (ratio 64:81) without also knowing the more consonant 5-Limit 4:5? What is far more likely is that the ancients knew *both* ratios, and accepted a culture of tuning *pluralism*. Many alternatives exist, and the tuner consciously chooses between them. The western branch of the Christian Church introduced a culture of tuning *monism*--there is only one 'correct' harmony and all else is 'of the devil.' Fortunately, this sectarianism was not shared by the eastern Christian churches. This situation helps explain why the early medieval music culture in the west remained crude and primitive, in comparison to the rich music cultures of Turkey and the Middle East at that time. The west did not develop a high music culture until around 1000 A.D., due largely to the infiltrations of Arabic science.

SIXTH CENTURY SCIENCE AND TECHNOLOGY

We return back to the potent time of the Milesians. Many modern interpreters of ancient philosophy contend that the Milesians were heroic and isolated figures who initiated science and even 'rationality' itself in spite of the superstitions of the surrounding cultures. It is worthwhile to include a section in order to demonstrate that they were not

alone, either in Ionia or surrounding regions. The sixth century was a momentous time of cultural developments.

Much of our knowledge of early Greek technology-science is of a legendary nature, but a core of those legends can be substantiated by indirect information and by monuments. Much of it was in imitation of Egypt, or directly introduced from Egypt and Babylonia. We will need to look at science in Egypt as well, but first here is a brief summary of some prominant Greek names in the field.

The earliest name in Greek technology is the semi-legendary Anacharsis, who came from Scythia to Athens in 594 B.C. He became a disciple and friend of Solon, and is sometimes listed among the 'Seven Wise Men.' Many inventions were credited to him, for example, the two-armed anchor, the bellows, and the potter's wheel. However, all of these items were extant much earlier than the 6th century, and it is now believed that he must have imported them from Egypt or elsewhere, or perhaps improved them in some way. At any rate, he is the first scientific figure to be associated with Athens.

Hecataeus of Miletus has already been mentioned in connection with Anaximander's map. He was born around the time of the conquest by Cyrus, and died in 475. As a citizen of the Persian Empire, he travelled far and wide, including a trip up the Nile as far as Thebes. Hecataeus is called the 'Father of Geography,' and he is said to have written a book called *Periodos ges* (description of the **earth**). He also wrote a historical work called *Geneaologies* (an intriguingly musical title) of which there is no trace. Various fragments and references to his map indicate that it was like Anaximander's. The world is surrounded by the 'Homeric Ocean' (***Okeanos***). By the world he means Europe, Asia, and Africa. Europe is roughly the same size as Asia-Africa, divided by the Mediterranean sea, and the center of the world is around Miletus. Hecataeus had his own theory about the flooding of the Nile, attributing it to its connection with the ***Okeanos***.

Cleostratos of Tenedos (a little island off Troas, near the mouth of the Hellespont), flourished around 520, making him contemporary with Pythagoras and Xenophanes. According to one tradition, Thales died there, and may have transmitted Milesian doctrines to him. At any rate, he was traditionally called the 'Father of Greek Astronomy.' He was known for two achievements. First, he recognized the Zodiac signs, especially the Ram and the Archer. Of course, he must have introduced these notions from Babylonia, where the Zodiac was conceived a thousand years earlier. Secondly, the eight-year calendar cycle called *Octaeteris* was ascribed to him. Again, this cycle was known to the Babylonians. He is said to have written a lost poem to the stars (*astrologia*). Like Thales, we must judge him to be a transmitter of Babylonian scientific astronomy to Greece.

Little is known of Glaucos of Chios, but he is said to have invented the art of soldering iron (*sideru collesis*). Various tools needed in the art of building--level, square, lathe, key--were attributed to Theodoros of Samos, who flourished around 550 to 530. He was a rather mysterious figure, said to be a technician, architect, brassfounder, goldsmith, and gem engraver. However, all of these tools and techniques were already known to the

Egyptians. His most famous project was the building (or re-building) of the gigantic temple of the Artemision in Ephesus (the city of Heraclitus), dedicated to the Asiatic nature goddess Artemis. He apparently solved the tricky problem of establishing solid foundations on marshy ground. His solution was so successful that the temple stood for many centuries. Theodoros was aided by a Cretan, Chersiphron of Cnossos, who devised a method of moving the huge columns. Presumably his son Metagenes carried on the work.

Theodoros was not the only scientific figure to be connected with the island of Samos. Among mathematicians, the most famous was Pythagoras (born around 570). However, the greatest of all engineers was Eupalinos of Megara, who flourished around 530, making him contemporary with Pythagoras. He built a famous water conduit on Samos during the reign of Polycrates (530-522). This tunnel, laborously dug through the mountain, was mentioned by Herodotus (III, 60), and rediscovered in 1882. It was about 1000 meters long and excavated starting at both ends. The junction in the middle was not absolutely perfect, but pretty close--a major feat. This was certainly a great achievement, but not the first of its kind. A similar tunnel was dug in Jerusalem under the reign of King Hezekiah (719 to 690). It isn't clear how these engineering works were accomplished, but they must have had some instruments to measure azimuth and differences of levels. The theoretical aspects of the problem were not published until the Hellenistic era, in the *dioptra* by Heron of Alexandria.

If Eupalinos was the first known Greek civil engineer, Mandocles of Samos (flourished around 514) was the first bridgemaker. Apparently, he was commissioned by Darius I (King of Persia, 521-485) to build a massive bridge across the Bosporos in order to enable his immense army to cross into Europe against the Scythians (according to Herodotus IV, 88).

The number of engineers here mentioned is the more remarkable since the vast majority of such technicians worked anonymously. But this period was famous not only for its engineers and architects, but also for its cultural historians. Cadmus of Miletus was called the 'Father of Greek Historians.' He was active around the middle of the century, and gave an account of the founding of Miletus, as well as the history of Ionia. Unfortunately, his work was totally lost. A little later (around 510) Eugeon of Samos also wrote the annals of his native island. Yet these beginnings of historiography were not confined to Greece. Around the same time, various Jewish writers documented some of the more historical segments of the Bible, notably the Book of Kings and the Book of Judges. The significance of the time must have sparked an interest in history.

In order to get a wider perspective on the sixth century, it is worthwhile to also consider developments in Egypt, the dominant cultural center of the eastern Mediterranean region. We must begin a little before the sixth century so that the relations between Greece and her neighbours can be clarified. The 25th (or Aethiopian) Dynasty of Egypt, having lasted barely half a century, came to an end in 663, when the last Aethiopian Pharoah was defeated by Ashurbanipal (king of Assyria, 668-626). For a few months, Egypt was an Assyrian province. But Psametik, son of Necho (Nekaw) of Sais expelled

the Assyrians with the help of Greek and Carian mercenaries, founding the 26th Dynasty (the Saitic Dynasty). He was a strong and able leader, and during his time Egypt (while still militarily weak) experienced a strong cultural-artistic renaissance. It was a time of great prosperity, although Egypt was still defensively weak and unstable. The Saitic period lasted 138 years, after which Egypt was conquered by Cambyses of Persia in 525.

Psametik made the mistake of putting culture over strength, but during his Dynasty the arts and sciences flourished. He repaired irrigation works, and favored the establishment of Greek, Carian, Phoenician, Syrian, and Israeli colonies on the Delta. There were Greek and Carian quarters in Memphis. This *internationalism* also worked the other way; for example, temples to Isis and Osiris were established in Miletus. Apparently, the Egyptians were 'popular' and respected in Greece; for example, Periandros (tyrant of Corinth) gave his successor the name Psammetichos (or Psammis), the Greek form of the Egyptian name Psametik. Periandros was also listed among the 'Seven Wise Men.' Thus we see the beginnings of a Greek-Egyptian cultural fusion.

Psametik was succeeded by his son Necho in 609. He was also artistically astute but militarily naive. Taking advantage of the Assyrian struggle against the Babylonians and Medes, he invaded Palestine, defeating king Josiah at the battle of Megiddo. Again, it was Greek mercenaries that made all the difference, and the two cultures drew closer together. Alas, four years later he was defeated by Nebuchadrezzar (king of Babylon, 604-562) and he lost his Asian territories, but the whole experience brought the Greeks and Egyptians closer together. After Megiddo, Necho went to visit the *Branchidai* (hereditary priests of Miletus administering the oracle of *Apollo Didymaios* at Didymus, close to Miletus), dedicating his victory garments to Apollo and paying homage to the Greek gods. It was this sort of cultural interaction which was the background for Milesian science.

Moreover, Necho himself embarked on various famous engineering projects. He resurrected a canal project to connect the Nile with the Red Sea. This project had been begun but abandoned during the Middle Kingdom (2160-1788 B.C.). Herodotus (II, 158) says that it was finally abandoned by Necho when they found that the Red Sea was higher than the delta, so that there was a fear that Egypt would be flooded with salt water. Darius, king of Persia and Egypt (521-486) completed it a century later. But Necho's most famous project was the circumnavigation of Africa. Anxious to promote foreign trade, he ordered Phoenician ships to sail around Libya (Africa). According to Herodotus (IV, 42), the project was successful, and took two and a half years. Perhaps this feat influenced Hecataeus in his geography. At any rate, Necho was admired by the Greeks. Solon of Athens went there to visit him and study his law codes, which were then incorporated into the Athenian code.

The last king but one of the Saitic Dynasty, Ahmose II, ruled from 569 to 525. He completely rebuilt and reorganized the Greek city of Naucratis on the Canopic branch of the Nile, very close to the capital city Sais. Its main sanctuary was called the *Hellenion*. He sent generous gifts to various Greek cities, and formed an alliance with Polycrates of Samos. Ahmose died in 525, but his son Psametik III was defeated that year by Cambyses

of Persia, ending the Dynasty. Meanwhile, the Nile Delta was already very Greek, and the Saitic Dynasty (663-525) has been called a precursor or an anticipation of the coming post-Alexander Ptolemaic Greek-Egyptian Dynasty which ruled a few centuries later (332-30 B.C.).

In conclusion, the period of the seventh and sixth centuries was a time in which the Near East was subjected to deep, unceasing turmoil. Its various cultural elements, Greek, Asiatic, African, were repeatedly mixed together. There occured a co-mingling of populations and ideas, religions and technologies. This intermixing is the relevant cultural background for the beginnings of philosophy-science in Greece. The hallowed notion, still believed by many modern academics, that Greek science was a 'purely' Greek invention with no influence or connection with the surrounding cultures, is simply untenable. The science, technology, and religious cosmologies of Milesian Greece could not help but be effected by its surroundings. The intermixing itself was the likely stimulus for these philosophical developments.

PLATO ON THE WORLD-BODY

Anaximenes was undoubtedly the most influential of the Milesian philosophers, so much so that later generations invariably meant Anaximenes whenever they referred to the Milesians. However, Anaximenes' doctrines were frequently attributed to later philosophers, especially Pythagoras. This situation came about partly because of the great influence of Plato, who was a defender of Pythagorean ideas. A good example of Milesian cosmology reflected through Pythagoreanism is found in Plato's *Timaeus*. In this section, and the next, we examine Plato's World-body and World-soul. The underlying premise of the whole piece is the Anaximenean notion that the world (the macrocosm) is isomorphic with the microcosm. The long monologue is put into the mouth of one Timaeus, a philosopher from southern Italy, which was a hot-bed of Pythagoreanism.

We will examine a segment of the dialogue starting with 31b and ending at 34b. In order to set the stage, we should remember the seminal monochord progression signified as 'point, line, surface, solid' and outlined in the first essay. Plato will be 'playing' with this material for our 'entertainment.' That progression, of course, referred to the emanation of the MONAD, DYAD, TRIAD, and PENTAD--the 'grandparents' (roots) of the harmonic universe. Plato already alludes to them in an oblique fashion at 30b:[83] '*...he further concluded that it is impossible for anything to come to possess intelligence apart from soul. Guided by this reasoning, he put intelligence in soul, and soul in body, and so he constructed the universe.*' The ***kosmos***, in the ancient musical model, is composed of an intelligible realm (2-Limit harmony, the DYAD), within a soul realm (3-Limit harmony, the TRIAD), within a 'nature' or 'body' realm (5-Limit harmony, the PENTAD). All of this is intensely Pythagorean-Platonic, although it has its source in the Milesians. Plato goes on to consider the 'makeup' of the body first.

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[83] Plato, *Timaeus*, 30b. Translated by Donald J. Zeyl.

*'Now that which comes to be must have bodily form, and be both visible and tangible, but nothing could ever become visible apart from **fire**, not tangible without something solid, nor solid without **earth**. That is why, as he began to put the body of the universe together, the god came to make it out of **fire** and **earth**.'*

The *god* is the ***demiurgos***, or 'craftsman' (***Hephaestos***, ***Ptah***). This passage obliquely defends the priority of the Elements **fire** (MONAD) and **earth** (DYAD) in the generation of the musical cosmos. These Elements have priority over the medial Elements of **air** and **water**. He goes on to 'insert' the medial Elements and informs us that they must be 'proportionate' (possess ***logos***); but the nature of this proportionality is not at all made clear:

*'But it is impossible to combine two things well all by themselves, without a third; there has to be some **bond** between the two that unites them. Now the best bond is one that really and truly makes a **unity** of itself together with the things bonded by it, and this in the nature of things is best accomplished by **proportion**. For whenever of three numbers which are either **solids** or **squares** the middle term between any two of them is such that what the first term is to it, it is to the last, and, conversely, what the last term is the the middle, it is to the first, then, since the middle term turns out to be both first and last, and the last and the first likewise both turn out to be the middle terms, they will all of necessity turn out to have the same relationship to each other, and, given this, will all be unified.'*

In the traditional progression, the TRIAD is generated as the musical *mean* between the MONAD and DYAD. This is accomplished by the *harmonic* and/or *arithmetic mean*. But here, the explanation clearly refers to the *geometric mean* instead. The geometric mean, remember, is the esoteric mean which generates an irrational ratio when generated between such important 'parent' ratios as 1:2 or 2:3. It appears that Plato is purposefully diverting us away from the proper generation of **air** and **water**. The geometric mean can, however, be rational under special circumstances. Specifically, if the 'parent' ratio forms a square number (i.e. 1:4) or a cube number (i.e. 1:8), then the geometric means are: 1:2:4 and 1:2:4:8. This proportionality satisfies the particular criteria given above. It is also sometimes written as 1:2::2:4 and 2:4::4:8 (that is, the first term is to the middle what the middle term is to the last, the last term is to the middle what the middle is to the first). It could also be written 4:2::8:4 or 4:8::2:4 (the middle term turns out to be first and last and the first and last terms turn out to be middles). In refering to '*solids*' and '*squares*,' he is reminding us that he is using the Pythagorean musical progression 'point, line, surface, solid,' but re-interpreting it The whole passage appears designed to make something very simple into something difficult or 'esoteric.'

Plato goes on to relate all of this to **air** and **water**:

*'So if the body of the universe were to have come to be as a two dimensional **plane**, a single middle term would have sufficed to bind together its conjoining terms with itself. As it was, however, the universe was to be a **solid**, and solids are never joined together by just one middle term but always by two. Hence the god set **water** and **air***

*between **fire** and **earth**, and made them as proportionate to one another as was possible, so that what **fire** is to **air**, **air** is to **water**, and what **air** is to **water**, **water** is to **earth**. He then bound them together and thus he constructed the visible and tangible universe. This is the reason why these four particular constituents were used to beget the body of the world, making it a **symphony of proportion**. They bestowed friendship upon it, so that, having come together into a **unity** with itself, it could not be undone by anyone but the one who had bound it together.'*

It is clear that Plato is referring to the Anaximenean musical universe of **fire**, **air**, **water**, **earth**, and that **water** and **air** are the 'medial' Elements, but the relation between them is not at all clear. He strongly implies that they should have a *geometric relation* between each other, rather than the traditional musical relations derived from the harmonic and arithmetic means. This deliberate obscurity is a typical example of Plato's approach to fundamental musical-cosmological matters. He lets it be known that the cosmology *is* musical in conception, with his talk of Elements, unity, proportion, and so on; but at the same time he is reluctant to provide any clear statement of the underlying musical 'truth.' In this regard, the Presocratics are much more transparent in their lay-out of underlying musical principles.

The statement that the god '*bestowed friendship upon it*' illustrates a much-used identification between 'friendship' and harmony. We are reminded of *Gorgias* 508a, where he says: '*...Wise men claim that partnership and friendship...hold together **heaven** and **earth**...and that is why they call this universe a **world-order**...*' In other words, the 'glue' of the ***kosmos*** is harmony, often appropriately described as 'friendship.'

Plato goes on to justify why *all* of the Elements were used in making the ***kosmos***:

*'Now each one of the four constituents was entirely used up in the process of building the world. The builder built it from all the **fire**, **water**, **air**, and **earth** there was, and left no part or **power** of any of them out. His intentions in so doing were these: First, that as a living thing it should be as **whole** and complete as possible and made up of complete parts. Second, that it should be just **one universe**, in that nothing would be left over from which another one just like it could be made. Third, that it should not get old and diseased. He realized that when **heat** or **cold** or anything else that possesses strong powers surrounds a **composite body** from outside and attacks it, it destroys that body prematurely, brings disease and old age upon it and so causes it to waste away. That is why he concluded that he should fashion the world as a single whole, composed of all wholes, complete and free of old age and disease, and why he fashioned it that way.'*

Plato claims that the *powers* of each of the Elements are essential in the make-up of the cosmos. The emphasis on it being a *whole* is typically musical. It is a whole made up of *all possible wholes* together. The cosmos is One in its multiplicity. The reference to *'heat and cold'* attacking a *composite body* is quite interesting. Here we have an oblique reference to the Anaximandrean notion that the *opposites* hot and cold are not only the cause of the generation the cosmos, but also the cause of its dissolution. Plato takes a jibe

at this justification of 'innumerable worlds,' by using the Parmenidean argument that even these 'wholes' make up one *whole* which is complete and 'immovable.' This is accomplished by using the full power of all the Elements.

Plato goes on in a long passage justifying the shape of the universe as a 'cosmic person.' *'And he gave it a shape appropriate to the kind of thing it was. The appropriate shape for that living thing that is to contain within itself all the living things would be the one which embraces within itself all the shapes there are. Hence he gave it a* ***round*** *shape, the form of a* ***sphere****, with its center equidistant from its extremes in all directions. This of all shapes is the most complete and most like itself, which he gave to it because he believed that* ***likeness*** *is incalculably more excellent than unlikeness. And he gave it a smooth round finish all over on the ouside, for many reasons. It needed no eyes, since there was nothing visible left outside it; nor did it need ears, since there was nothing audible there, either. There was no* ***air*** *enveloping it that it might need for breathing, nor did it need any organ by which to take in food or, again, expel it when it had been digested. For since there wasn't anything else, there would be nothing to leave it or come to it from anywhere. It supplied its own waste for its food. Anything that it did or experienced it was designed to do or experience within itself and by itself. For the builder thought that if it were self-sufficient, it would be a better thing than if it required other things.*

And since it had no need to catch hold of or fend off anything, the god thought that it would be pointless to attach hands to it. Nor would it need feet or any support to stand on. In fact, he awarded it the movement suited to its body--that one of the seven motions which is especially associated with understanding and intelligence. And so he set it turning continuously in the same place, ***spinning around*** *upon itself. All the other six motions he took away, and made its movement free of their wanderings. And since it didn't need feet to follow this circular path, he begat it without legs or feet.'*

This argument is entirely an expansion of the argument by Empedocles, who, in typically Presocratic fashion, conceived of the whole as a macrocosmic being which has the form of a sphere. Within Hippolytus (*Ref.* VII, 29, 13) we have fragment 29: *'And as to the form of the cosmos, he describes what it is like when ordered by Love* [harmony] *in the following manner: 'No twin branches spring from its back, it has no feet, no nimble knees, no fertile parts,' but 'it was a sphere,' and is equal to itself.'* Again, we see fragments 27 and 31 in Simplicius (*in Phys.* 1183, 28): *'Eudemus understands the immobility to apply to the Sphere in the supremacy of Love, when all things are combined-- 'there neither are the swift limbs of the sun distinguished,' but, as he says, 'thus it is held fast in the close obscurity of Harmonia, a rounded sphere rejoicing in its joyous solitude.' But as Strife* [dissonance] *begins to win supremacy one more, then once more motion occurs in the Sphere; 'For one by one all the limbs of the god began to quiver.''*

In this manner, the physical world is a reflection of the higher god who is musical in his essence: *'Applying this entire train of reasoning to the god that was yet to be, the eternal god made it smooth and even all over, equal from the center, a whole and*

complete body itself, but also made up of complete bodies. In its center he set a ***soul****, which he extended throughout the whole body, and with which he then covered the body outside. And he set it to turn in a circle, a single solitary universe, whose very excellence enables it to keep its own company without requiring anything else. For its knowledge of and friendship with itself is enough. All this, then explains why this world which he begat is a blessed god.'*

The justification for a *World-soul*, then, is the isomorphism between the microcosmic and the macrocosmic 'man,' even though the macrosmic being does not need a specifically human form. Since it is a higher being than us, it can have a more perfect shape, that of an apeirous sphere. Yet it is endowed with a Soul and consciousness, in order to account for the orderliness and perfection of nature. For Plato, the world itself was a veritable god.

PLATO ON THE WORLD-SOUL

Having described the *World-body* in an obscure but highly musical manner, he proceeds to consider the *World-soul*. The passage continues from the last one, starting at 34c. But before defining the cosmic 'psychology,' he wants to emphasize its priority over the cosmic 'physiology:'

'As for the world's ***soul****, even though we are now embarking on an account of it after we've already given an account of its body, it isn't the case that the god devised it to be younger than the body. For the god would not have united them and then allow the elder to be ruled by the younger. We have a tendency to be casual and random in our speech, reflecting, no doubt, the whole realm of the casual and random of which we are a part. The god, however, gave priority and seniority to the* ***soul****, both in its coming to be and in the degree of its excellence, to be the body's mistress and to rule over it as her subject.'*

Alas, the obscurity of his account concerning the *World-body* is also evident in his description of the *World-soul*. Perhaps it is worse:[84]

'The componants from which he made the ***soul*** *and the way in which he made it were as follows: In between the* ***Being*** *that is indivisible and always changeless, and the one that is divisible and comes to be in the corporeal realm, he mixed a third, intermediate form of being, derived from the other two. Similarly, he made a mixture of the* ***Same****, and then one of the* ***Different****, in between their indivisible and their corporeal, divisible counterparts. And he took the three mixtures and mixed them together to make a uniform mixture, forcing the* ***Different****, which was hard to mix, into conformity with the* ***Same****. Now when he had mixed these two together with* ***Being****, and from the three had*

[84] This interpretation of the Platonic material is only one of a number of possibilities. Due to the complexites and obscurities of Plato's account, and the historical 'popularity' of the *Timaeus*, probably his most influencial work, many different commentaries have been produced. For a number of variant historical solutions, see McClain, *The Pythagorean Plato*, p. 158, and also chapter 5, p. 57-70.

made a single mixture, he redivided the whole mixture into as many parts as his task required, each part remaining a mixture of the ***Same****, the* ***Different****, and of* ***Being****.'*

The Same, the Different, and Being are sometimes translated as the Circle of the Same (or Unchanging), the Circle of the Different (or Changing), and the Circle of Being (or the Existent, sometimes, the Circle of the Essence), the mixture of the first two circles. In spite of the obscurity, we recognize several familiar Pythagorean elements. The *Same*, or the Unchanging, is derived from ***Peras***, the One, the Unity. It is 'unchanging' because the One is omnipresent within all harmonic constructions. Its indivisibility seems to be a paradox (since the One is divided into the Many), but it may refer to the traditional monochord practice of expressing all patterns in whole numbers by using least common multiples. In this sense, the One (the individual unit) is always preserved. Moreover, the *Different* or the Changing is derived from the ***Apeiron***, associated by the Pythagoreans with the Many. They also associated it more with the corporeal, the 'matter' of the universe, as opposed to the 'form' given by ***Peras***. Both aspects are necessary in order to generate the Existent, the Circle of Being. The production of a third 'circle' (generated from the previous two aspects) reminds us of the Pythagorean generation of the *mean* between two 'parent' elements. Specifically, the MONAD (***Peras***) and the DYAD (***Apeiron***) generate the TRIAD (the Existent). With these associations in mind, were are given more useful information in the next part:

'This is how he began the division: first he took one portion away from the whole [1], *and then he took another, twice as large* [2], *followed by a third, one and a half times as large as the second and three times as large as the first* [3]. *The fourth portion he took was twice as large as the second* [4], *the fifth three times as large as the third* [9], *the sixth eight times that of the first* [8], *and the seventh twenty-seven times that of the first* [27].*'*

Now it is clear that the Same and the Different refer to two number progressions, as well as having the associations mentioned above. The Circle of the Same stands for the number progression 1:2:4:8. It is appropriately named, because, musically, (whether on a monochord or its reciprocal harmonic series) the progression generates only octaves of the same pitch ('C'). It is what we call '2-Limit' harmony. Meanwhile, the Different refers to the number progression 1:3:9:27. While the former progression uses powers of the DYAD, the latter uses powers of the TRIAD. It generates the material that we call '3-Limit' harmony. While the former progression does not generate new musical elements, the latter progression generates ongoing diversity. We can now safely conclude that Plato's monochord construction is to be 3-Limit, since it uses only compounds derived from these two series of numbers. Such a 3-Limit harmony is appropriate to the *World-soul*, since, for Plato, the realm of *soul* is associated with the Anaximenean Element **air**.

The number progressions also show that Plato is not using the traditional associations of ***Peras*** and ***Apeiron*** in the usual manner. We would normally associate them with MONAD and DYAD, but here they are associated with DYAD and TRIAD. This is typical of the creative (if somewhat confusing) way that Plato manipulates the older

musical elements. Also, the *mixture* of the two cannot be the usual *mean* between 1:2 that we expect. It must stand for the formation of one monochord sequence which combines the two progressions, forming a Circle of the Existent. Using least common multiples, if we want to combine the two sequences into one linear octave sequence on the monochord, the arithmetic gives us 16:18:24:27:32 (pitches C:\Bb:F:\Eb:C). But before combining the two progressions in this way, Plato stipulates further conditions:

'After this he went on to fill the double and triple intervals by cutting off still more portions from the mixture and placing these between them, in such a way that in each interval there were two middle terms, one exceeding the first extreme by the same fraction of the extremes by which it was exceeded by the second, and the other exceeding the first extreme by a number equal to that by which it was exceeded by the second. These connections produced intervals of 2:3, 3:4, and 8:9 within the previous intervals.'

The two middle terms clearly consist of the traditional *harmonic and arithmetic means*. In other words, we are first to find the means between the terms of our two progressions, then take all of this material and combine it into one Circle of the Existent or Essence, the 'off-spring' of the two 'parent' progressions. Plato has now finally clarified that he *is* making a monochord construction as his metaphor for the *World-soul*. In order to find the means between the elements of the progression 1:2:4:8, we must multiply the numbers by six; then we can insert the desired means. This progression will give us the sequence **6**:8:9:**12**:16:18:**24**:32:36:**48**. The original numbers, multiplied by six, are shown in bold with the two means inserted between them. The resultant pitches are octaves of C, F, and G. In order to find the means between the elements of progression 1:3:9:27, we need only multiply the elements by two, yielding **2**:3:4:**6**:9:12:**18**:27:36:**54**. The resultant pitch material is the same as the sequence ruled by 16:32 presented above. Note that all numbers used in these operations are 3-Limit (multiples of the prime numbers 2 and 3--no multiples of 5 or higher primes are allowed).

Now we can combine this material into one octave sequence, forming the Circle of the Existent. We get the pentad harmony defined by the numbers 48:54:64:72:81:96, or, in pitches C:\Bb:G:F:\Eb:C. However, Plato is not yet finished with his construction. He gives further instructions:

'He then proceeded to fill all the 3:4 intervals with the 8:9 interval, leaving a small portion over every time. The terms of this interval of the portion left over made a numerical ratio 243:256. And so it was that the mixture, from which he had cut off these portions, was eventually completely used up.'

In other words, he wants us to inspect this harmony for 3:4 (musical fourth or tetrachord) relations. They do exist between 48:64, 54:72, and 72:96. We are to 'fill in' these musical fourths with the 3-Limit Diatonic tetrachord which consists of two wholetones of 8:9 and a semi-tone of ratio 243:256. Using smallest terms, this important tetrachord has the number progression 192:216:243:256 (or pitches C:\Bb:\Ab:G). In order to do this in least common multiples, we must multiply the above pentad harmony

by 32. The final result is sequence 1536:1728:1944:2048:2187:2304:2592:2916:3072, a musical ogdoad (eight note) harmony, in pitches C:\Bb:\Ab:G:F#:F:\Eb:\Db:C.

By this construction, Plato indicates to us that he is no 'novice' when it comes to a knowledge of Canonics. First of all, he has conveniently generated an *ogdoad harmony*, which is just what is needed for any monochord version of the cosmic 'planetary music.' Traditionally, there are eight celestial spheres, with the **earth** in the middle to make nine celestial bodies. Hence this scale can be 'projected' onto the ancient planetary sequence if we take the one 'C' as **earth**, and its octave 'C' as **heaven**. If he had given different instructions, he could have ended up with a scale which as too many or too few elements. We should assume that this is no co-incidence--he knew what he was doing. Hence it fulfils the requirement that the mixture was '*divided into as many parts as his task required.*' Moreover, as already indicated in the first essay, the 3-Limit ogdoad has special musical properties within Canonics. Any further expansion generates elements which are 'quasi-5-Limit.' Consequently, there is a particular and significant meaning to the statement that, with this construction, all the elements are '*completely used up.*'

Of course, this is not the only possible 3-Limit ogdoad harmony. Obviously, there are eight possible patterns or *modes* of this harmony. The most important mode is ruled by the division 1152:2304. There is no reason to think that Plato was unaware of the other possibilities. Moreover, these eight possible modes have eight 5-Limit 'close cousins' or closely related harmonies (differing only by select comma-shifts). Amazingly enough, Plato has 'suggested' the 5-Limit 'cousin' of this harmony through the process of this construction itself! Specifically, the intermediate division 48:96 could conceivably suggest the 5-Limit division ruled by 96:192, i.e. 96:108:120:128:135:144:160:180:192, or in pitches C:\Bb:Ab:G:\Gb:F:Eb:Db:C. Compare this scale with its somewhat more dissonant 3-Limit version above. Of course, the most famous (and consonant) mode of this harmony is division 72:144. Perhaps this whole construction is a way of deviously 'hinting' at this traditional construction for the Pythagorean 'harmony of the spheres.'

Having constructed his planetary harmony, he now proceeds to apply it to the cosmic system. This involves making the Circle of the Same stand for the outer sphere of the stars responsible for the constant daily rotation of the heavens. The other 'Circle of the Different' is divided into the bands of the planets, the 'wanderers' which move in a contrary direction in relation to the stars:

'Next, he sliced this entire compound in two along its length, joining the two halves together center to center like an X, and bent them back in a circle, attaching each half to itself end to end and to the ends of the other half at the point opposite to the one where they had been joined together. He then included them in that motion which revolves in the same place without variation, and began to make the one the outer, and the other the inner circle. And he decreed that the outer movement should be the movement of the Same, while the inner one chould be that of the Different. He made the movement of the Same revolve toward the right by way of the side, and that of the Different toward the left by way of the diagonal, and he made the revolution of the Same, i.e., the uniform, the dominant one in that he left this one alone undivided, while he

divided the inner one six times, to make seven unequal circles. His divisions corresponded to the several double and triple intervals, of which there were three each. He set the circles to go in contrary directions: three to go at the same speed, and the other four to go at speeds different from both each other's and that of the other three. Their speeds, however, were all proportionate to each other.'

The movement of the stellar realm is the dominant motion, the others moving in '*contrary*' direction. Three of the wanderers move '*at the same speed*' because Mercury and Venus tend to stay 'in the neighbourhood' of the sun. Having now generated the *Soul* (the 3-Limit foundation of harmony), he puts it within the '*body*' (the 5-Limit):

*'Once the whole **soul** had acquired a form that pleased him, he who formed it went on to fashion inside it all that is corporeal, and, joining center to center, he fitted the two together. The **soul** was woven together with the body from the center on out in every direction to the outermost **limit** of the universe, and covered it all around on the outside. And, revolving within itself, it initiated a divine beginning of unceasing, intelligent life for all time. Now while the body of the universe had come to be as a visible thing, the **soul** was invisible. But even so, because it shares in reason and harmony, the **soul** came to be as the most excellent of all the things begotten by him who is himself most excellent of all that is intelligible and eternal.'*

The placement of the *soul* within the body thus carries on the monochord analogy. Just as the scale begins at the center (the *mese*) and continues out to the furthest *limit* of the ***kosmos*** (the largest monochord number in the division, the double of the *mese* number), so the body is joined from the center on outward to the limits of the universe. The macrocosmic *soul* is thus placed in the macrocosmic being. It is easy to recognize, in this whole mystical Pythagorean construction, an expansion of the Milesian metaphor of microcosm-macrocosm. The invisible **air**, *soul*, is equated with the intelligence of the world.

THE SIGNIFICANCE OF THE MILESIANS

Homer, Hesiod, and the other early poetic writers sang songs about the gods who exist forever. Their poetic language evolved an appropriate grouping of similes and metaphors, images and ideas, which expressed a musical view of the world. Such an outlook was totally natural in a social context where society was largely non-literate and story-telling was the basis of history. Hence they presupposed a sonic orientation to the sensorium and to 'reality' in general. Their metaphorical language of images gradually evolved into the ancient notion of *Music*--a universal order which was fundamentally aural. This order was described through poetic terms which may still have been largely subconscious in their musical associations. When they came to expressing the beginning and development of the world, they naturally used metaphors which describe the emersion of complexity out of simplicity, the Many out of the Unity. Alternatively, they described the beginning of the world as the establishment of a musical order (***kosmos***) out of the background confusion or 'noise.' The central image of the separation of **heaven** and **earth**, the establishment of the primary and prior Elements, and the begettings of the gods

through marriages and other fertility images, was entirely appropriate to this view of the world; indeed, these images and presuppositions were extremely widespread in the ancient world.

With the advent of the early philosophical cosmologists, a new element was added to this mix, although they largely preserved the poetic language and orientation of the early poets. This element was 'enquiry' (***istoria*** or ***historie***), which we could roughly call 'science,' an effort to probe and properly define the immanent musical order more deeply. They sought to express the underlying principles and features of Music, its morphology and its peculiarities. The old poetic language was preserved but deepened by conscious notions entirely appropriate to the musical context. Hence the early philosophers made commentaries on the root Elements of musical cosmogony and other issues which confirm the ancient notion of a musical order. Inevitably, they also began to uncover paradoxical or problematic features of the musical paradigm, and sought a language of concepts and images to express these issues. This language is the context of early Greek philosophy.

The Milesians, and their successors, made commentaries within a common cosmological framework of images and ideas. It is helpful here to briefly summarize the principal features of this cosmology:

1. Everything vibrates, or is *vibration* itself, vibratory motion is eternal, and the laws of vibration (accessible through the study of Canonics) pervade the universe or are equated with the universe itself.
2. The universe is a ***kosmos***, a vibratory *whole* in which the Many have a relationship to the One. This relationship is musical in nature.
3. Any investigation of the underlying principles, the source (***arche***), and the process of emanation of the cosmos presupposes or takes into account the demonstrable features of Canonics.
4. The *emanation* of the cosmos is defined as ***physis***, an organic or natural 'growth' which has properties independant of any arbitrary human conventions (***nomos***). It is not an artistic human design (***techne***) but an 'artistic' work of nature itself.
5. The process and the results of cosmogonical emanation have an inherent underlying *order* based on ratio (***logos***) and temporal relatedness.
6. The vibratory complexities of the world emerge as 'citizens' who are born out of some indispensable ancestors or 'grandparents,' which are defined as the *Elements* or *roots* of the harmonic realm. These Elements are themselves absolutely primary (**heaven** and **earth**) or medial (**air** and **water**). They generate the composites, the Many.
7. The universe is pervaded by *Forces* of attraction and repulsion (Love and Hate) derived from harmony-dissonance, or simplicity-complexity.
8. These Forces obey the law that *like attracts like*, or is akin to like. These same Forces set in motion the eternal movement of the vibratory universe (the **vortex**), the 'spinning out' of complexity from the original Unity.
9. The Forces, indeed, the Elements and other features of the cosmos, display an underlying opposition or *reciprocal nature* which is expressed through the **opposites** and

applied to many divergent cosmological contexts. These opposites could be initially derived from the cosmogonical primary Elements (**heaven** and **earth**).
10. The original opposites display the omnipresent **cyclical nature** of the universe, which is ruled by **Time**. The characteristic metrical features of Time are demonstrable through Canonics.
11. The cyclical nature of the eternal motion is definable through **Number** and interval.
12. The metrical properties of cyclical motion inevitably generate issues concerning the measurable **limits**, or lack of limits of vibratory phenomena. Hence the terms ***Peras*** and ***Apeiron*** are central to early philosophy.

In the last few essays, we have investigated the cosmological ideas of the three seminal Milesian philosophers: the elusive and esoteric Thales, the profound and radical Anaximander, and the catholic and influential Anaximenes. The conceptual language and images of these philosophers already supports an advanced awareness of the issues presented above. We should suppose that this cosmological model (the *resonance paradigm*) was then handed down to their followers within the Presocratic philosophical movement. These philosophers then variously defended or criticized the numerous implications of the musical model given them. The significance of the Milesians and the other early (6th century) cosmologists lies in their successful efforts to define the very language and conceptual framework of this Musical 'science' in the making. Later philosophers accepted this same language and developed its terminology and implications. The work of the 5th century cosmologists would be impossible without their foundation.

This assessment of the Milesian philosophers is quite at variance with the modern standard accepted academic stand. In practically all modern textbooks one reads that the Milesians invented 'rationality and science' as a creative reaction against the 'superstitious religions' of their culture. They do not recognize that the movement itself was religious in its orientation, or at least, it was not in opposition to the religious impulse of their culture. It was a probing of the very basis of their religion itself, a deepening of their understanding of its underlying presuppositions. Hence it was similar in character to the contemporary Upanishadic writings in India, which plumbed the depths of their musical mythology also evident in the Vedic literature. The aim was not to negate it, but rather to understand its basis. The language and issues which preoccupied Presocratic philosophy were to remain of relevance to religion for the next millenium in Greece. Only slowly were they 'mutated' and re-interpreted for a different social context, as Music gradually disintegrated.

The typical modern interpretation of the place of the Milesians is very succinctly summarized by Kirk and his associates:[85] '*...after the Milesians the old cosmogonical approach, according to which the most important object was to name a single kind of material from which the whole differentiated world could have grown, was both enlarged and moderated. New problems, of theology and of unity in the arrangement, rather than the material, of things, exercised Anaximenes' successors Xenophanes and Heraclitus--although they too (even though the former migrated) were Ionians. Still more basic*

[85] Kirk, Raven, and Schofield, *The Presocratic Philosophers*, p. 162.

departures from the Milesian tradition were made in the west [by the Pythagoreans and Eleatics].' This interpretation makes the presumption that issues of theology and unity were only introduced later, and that the Milesians themselves were 'purely scientific and rational.' It seeks to deny any religious dimension to Milesian philosophy. Moreover, it perpetuates Aristotle's reductionist scientific agenda--that the early philosophers were *only* materialists who were interested solely in 'the material of things.' According to the modern view, they made only systematic physical explanations of purely physical phenomena. This is a serious (but *so* widespread) misunderstanding of the more profound intentionality of the early philosophers themselves. It seeks to isolate the cosmologies of the various philosophers from each other, as if they were in competition with each other, rather than being commentators on a single unified underlying cosmology based on Music. Finally, it judges the early philosophers as 'naive monists' whose ***arche*** presupposes no knowledge or appreciation of the other musical Elements. The cumulative result of all these misconceptions is to place the Milesians in the position of being 'non-religious scientists' whose doctrines were 'crude' but heroically (even miraculously) free from the mythological framework of their culture.

As we have seen, the evidence indicates that the Milesians were not 'closet athiests' who banished religion from science. Rather, they supported a genuine religious impulse which can best be described as Orphic. In archaic Greek culture, there was no professional priesthood which interpreted the mythological stories for 'the masses.' Instead, the poets and bards fulfilled this funtion, and the masses were not yet monolithic. Ancient religion in Greece had a strong creative element and was not yet fixed, fixated, or confined by an orthodoxy based on a 'sacred book.' The closest thing that the Greeks had to a 'sacred book' was the poetry of Homer and Hesiod, but the cosmologists (and the dramatists) were free to 'play' with this material and interpret it creatively as they chose. The early philosophers should be put into this social context. They were the spiritual commentators of their cultural traditions, and probably appealed mainly to the minority of the population which was more educated or inquisitive. They did *not* stand in opposition to religion; instead, they enriched it.

-written July, August 1998, Amsterdam