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Chapter



Pythagorean Esotericism

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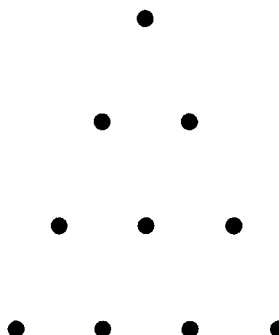


French version

In the 6th Century BCE, Greater Greece stretched west all the way to Sicily and southern Italy. At this time its western colonies were suddenly reinvigorated by an influx of refugees chased out of Ionia by the conquering Persians. **Pythagoras**, who was born on the island of Samos some time before 550 BCE, at a time when the whole of eastern Greece was becoming unsafe, settled at Croton in Sicily, probably before 520 BCE. A great many legends soon sprang up around this mysterious figure. By the end of the 5th Century BCE there was no longer any reliable source of information on the life and works of **Pythagoras** or his immediate successors. What is clear is the reason behind this mystery: it lies in the doctrine itself and the teaching methods of the man who was called the Master. Nothing **Pythagoras** taught was to be written down or divulged to the uninitiated, and even the disciples were divided into two classes, the μαθηματικοί (mathematikoi), who were students privileged to know the thoughts of the Master, and the ακουσματικοί (akousmatikoi), the mere listeners, allowed to know a little of his teaching but unworthy of the name of Pythagoreans. Furthermore, to avoid the common illusion by which some people think they made a discovery themselves, when in fact they merely happen to be the medium through which that discovery is crystallised, all thoughts and new ideas that came out of the reflections of the Pythagorean circle were attributed to **Pythagoras** himself, even long after he had died. So it is probable that the famous theorem that bears his name was devised long after his time.

Secrecy must have been carefully guarded, and relatively few of the Pythagoreans left any written records. It is even said that some were punished by death (by Fate, or with the help of zealous members of the brotherhood, as in the case of **Hippasus**) because they divulged a little of the esoteric knowledge they had acquired. In its cosmogony, the Pythagorean school draws partly on Milesian thought, but most of the thinking associated with the school is probably of eastern rather than Greek origin. Science and ethics were closely mingled, brought together via an explicit dualist hypothesis into a religious theory (whence the importance of the esoteric aspect). Body and soul (here ψυχή, but regarded as immaterial) were separate entities (1); and the immortal soul could inhabit different bodies as a result of metempsychosis (2), sometimes the bodies of all kinds of animals. This property of the soul, and the numerical constraints associated with all objects, whether material or immaterial, involved a great many necessities and incompatibilities. The Pythagoreans respected many taboos and followed a very strict moral code, taught via a special system of education (3). All passion, all excess, was to be avoided, so as to preserve the harmony of the soul (4). The Pythagoreans also believed adamantly in true friendship, and each member of the School would have done everything for a fellow member in difficulties, ruling out all rivalry and jealousy. The fact that all discoveries were attributed to **Pythagoras** himself helped to avoid any tension caused by the vain desire for intellectual property. According to **Aristotle**, to whom we owe most of what we know about the Pythagoreans, they held that the primary nature of things was Number. Some even regarded things as *being made of numbers*. **Eurytus**, a pupil of the Pythagorean **Philolaus**, demonstrated this in graphic fashion. He used small coloured stones, which he stuck on a wall prepared with plaster, to show that the number of mankind was 250, and that of plants was 360 (5). Others gave a more subtle role to number by associating an explanatory figure with each thing (for instance, a square had the number four), or by postulating that *relationships* between numbers explained objects, in the same way as the proportions in a recipe.

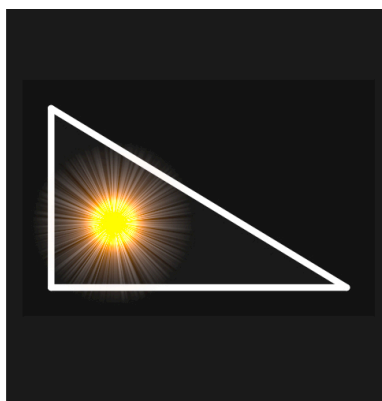
The Croton school proper was short-lived, for it did not survive the destruction of the city in 450 BCE, but a school inspired by Pythagoreanism lasted for several centuries throughout southern Italy. During the first period, three main lines of thought were developed: arithmetical thinking, the study of the properties of sound, and the geometric principles of the form of the Universe. Arithmetic and geometry were without doubt partly inspired by Milesian physics and the eastern tradition behind them: for instance, **Diogenes Laertius** records that the Γνώμων (Gnomon) had been invented by **Anaximander**. Two arithmetico-geometric figures illustrate the issues that particularly interested the Pythagoreans. The Τετρακτύς (Tetractys), used by the Pythagoreans as a symbol of membership, is a triangle formed from the first four whole numbers:



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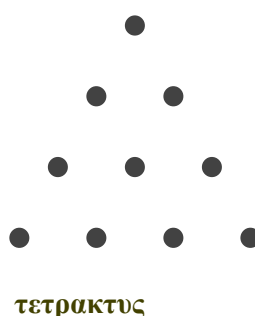
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Pythagorean esotericism (© Antoine Danchin, translation Alison Quayle)

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which add up to 10, the sacred Decad, symbol of the pairs of opposites that give birth to the Universe.



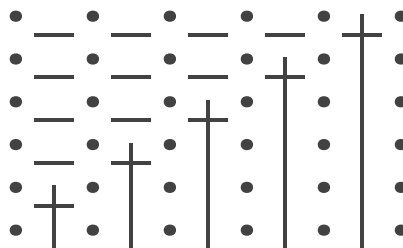
Ainsi, par une tradition continue, chaque théorie physique passe à celle qui la suit la part de classification naturelle qu'elle a pu construire, comme, en certains jeux antiques, chaque coureur tendait le flambeau allumé au coureur qui venait après lui ; et cette tradition continue assure à la science une perpétuité de vie et de progrès.

Pierre DUHEM

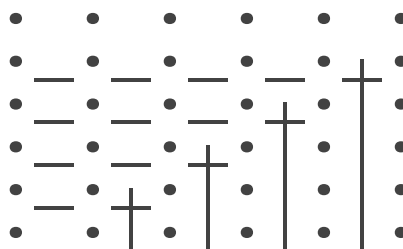
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The Γνωμον (Gnomon), a pair of recurring figures produced by moving regularly spaced points, enables all the geometric figures to be represented (6).



τετραγωνον



ετερομηκες

The odd Γνωμον generates all the odd numbers from the Monad or unity. Because it is symmetrical, it also generates the square and figures related to it. The even Γνωμον generates the even numbers and rectangular figures. The fundamental role of geometrical construction was part of the more general emphasis laid by **Pythagoras** and his disciples on the role of memory, or rather the act of accessing memory, or recall (αναμνησις *anamnesis*), in the processes leading to perfect knowledge. It was not enough to know that everyone had a soul which had had numerous experiences during its former lives; it was necessary to be able to revive the memory of the past at any time. The μαθηματικοι had to train their memory every evening by remembering all the events of the past day. By doing this they hoped to become able to remember the history of their souls, and perhaps to avoid it having to pass through an appropriate rite of purification during the cycle of rebirth (the same preoccupation is found with **Empedocles**). This is summed up in the admirable words of **Alcmaeon of Croton**:

τους ανθρωπους δια τουτο αμολυσθαι, οτι ου δυναται

Human beings perish because they are not able
to join their beginning to their end.

Difficult as it is to know the exact origins of geometry (and we know how interested Thales was in this), the early Pythagoreans were probably the first to study polygons and the regular polyhedra. They discovered all the regular convex polyhedra: the tetrahedron, the cube, the octahedron, the dodecahedron and the icosahedron, and used them to explain the geometric properties of all the objects met with in the Universe (7). **Hippasus of Metapontium** was expelled from the Pythagorean school because he betrayed the convention by revealing how the dodecahedron is constructed, and its relation with the regular pentagon (the faces of the dodecahedron are pentagonal). It is even said that he was drowned. Finally, it was during the early life of the Croton school that the notion of incommensurability was discovered (through the study of right-angled triangles whose sides are measured in whole numbers), and that the problem of squaring the circle was first addressed. Music was another fundamental question in the early days of Pythagoreanism, and it is thought that Hippasus first discovered the rules that govern the pitch of sounds, and especially the interdependence between intervals in music and certain numerical relationships.

Later, the rules of Pythagorean cosmogony were codified, and summed up in the form of a set of ten Oppositions:

περας	και απειρον	Limited Unlimited
περιττον	και αρτιον	Odd Even
εν	και πληθον	One Many
δεξιον	και αριστερον	Right Left
αρρεν	και θυλη	Male Female
ηρεμουν	και κινουμενουν	Immobile Mobile
ευθη	και καμπυλον	Straight Curved
φως	και σκοτον	Light Dark
αγαθον	και κακον	Good Evil
τετραγωνον	και ετερομηκες	Square Rectangular

The most remarkable thing about this varied list (about which Aristotle was fairly sarcastic) is the association between the

Unlimited, the Even, and Evil (Plato later developed this further). It implied an association between infinity and imperfection, disproportion, or **ὑβρις** (hybris). In contrast, the finite (and usually every cosmos (κοσμος, especially our own, was conceived as closed and limited), together with regularity, symmetry (for instance, the symmetry of polygons or regular polyhedra) were regarded as symbols of perfection. In appropriate combinations, this set of ten pairs of opposites should be enough to provide an accurate representation of the whole world.

The Monads were principles of Unity, unmixedness, measure, and purity. They were seen as points in space, with a certain breadth. Organised in space and set in motion, they could generate all possible shapes, first the simple geometric shapes (such as those found from the **Γνωμον**) and then the others.

The texts of Archytas (a contemporary of Plato and pupil of Philolaus) are particularly revealing. He discussed the properties of the Monad (which divides the world into two: odd and even, through simple self-addition of the Monad, one), defined arithmetical, geometrical and harmonic progression (8), and used them as the basis for the rules of music. Above all he gave geometrical proof for a number of theorems involving the generation of three-dimensional figures from the regular movement of the simplest figures: the cylinder is described by a straight line following a parallel path around a circle; the torus by a circle whose centre moves around a larger circle; and the cone by a triangle revolving around one of its sides.

Archytas was also among those who demonstrated that, despite what the apparent perfection of the Universe might lead us to believe, in fact it is infinite. To do this, he took the Milesians' spherical conception of the Universe and argued thus: if I had reached the outer limit, in other words the sphere of the fixed stars, would I, or would I not, be able to stretch out my hand, or my staff, beyond that? And the answer is yes, at any point on this apparent frontier. This implies that the laws of physics are the same at all points in the Universe, and that it would be absurd to imagine that it has any limit.

But the most revealing insight into Pythagorean cosmology probably comes from what is left of the writings of Philolaus of Tarentum. In this cosmogony, the Earth was no longer the centre of the world. For Philolaus, as for his predecessors, the

Universe was made of pairs of opposites, the Limited (the Monad) and the Unlimited (the Decad) (9). The Decad contained in itself the intrinsic nature of the point (unity), the straight line (two), the surface (three, since a triangle is the simplest surface) and space (four, represented by the tetrahedron, the first regular polyhedron and the first three-dimensional figure) (10). But it did not stop there: the number five generated Quality and Colour; six, the impulse of life (ψυχωσις), seven, mind (νοῦς) health and light; and eight was the number of love (ἔρως), friendship (φιλία), cleverness and intention (εἰπινοία). But it was not so much the numbers themselves as the geometrical properties that went with them that were the basis for understanding the world (11). In his *Timaeus*, Plato later took up this Pythagorean hypothesis, and associated four of the regular solids with the four elements: the tetrahedron with Fire, the octahedron with Air, the icosahedron with Water and the cube with Earth. He went on to postulate that the dodecahedron was the (limited!) figure that symbolised the Universe.

The whole world was organised around a nucleus, the central Fire, with the Ten Celestial Bodies arranged concentrically around it (12). From the periphery inwards, there were the stars, the five planets (Saturn, Jupiter, Mars, Venus and Mercury),

the Sun and the Moon, and finally, between the Moon and the central Fire was **Ἀντιχτον**, the Counter-Earth. This last heavenly body, which hid the centre of the Universe from our sight, and was itself invisible (since the face of the Earth was always turned away from it, just as the dark side of the Moon is always invisible from Earth), was inhabited by living beings.

Philolaus divided this Universe into three main regions, the outer region or **Ὀλυμπος** (Olympos), which contained pure elements; the intermediary region or **Κοσμος** (Cosmos) containing the five planets, the Sun and the Moon; and the inner region, **Οὐρανός** (Ouranos), home of Earth and Counter-Earth. The Earth and its counterpart revolved together around the central fire which he called the Hearth, in the same direction as the Sun and the Moon but in a different orbital plane. The Sun was a transparent lens that concentrated the light of the fire in the Olympian Ether. The Moon was inhabited (13) and its day lasted for fifteen earth days, making its inhabitants fifteen times stronger and more beautiful than humans.

The Pythagorean tradition involved not only a cycle in the life of the soul, but also a cycle in astronomical phenomena, which could be detected using the right arithmetic. The Great Year (the period of these phenomena) had been the subject of scholarly conjectures, and Oenopides of Chios (who was probably not a Pythagorean, but was certainly well informed about the work of the sect) had calculated the length of the Great Year as 59 years of 365 days and 22/59ths (14). Looking at his tables again, Philolaus realised that a small modification would give a Great Year of $9^3 = 729$ months, one month less than Oenopides' year, which he thought much more satisfactory, giving 364 and a half days per year (15). This made it possible to endow number with enormous power over the laws that governed the Universe.

The Pythagoreans were not only interested in cosmology. Like their predecessors and their contemporaries, they were fascinated by biology, which they approached via the study of acoustics and the physics of music (for which they are still known today), and also by the interpretation of the intrinsic properties of living beings. In music, besides Pythagoras himself the most prominent figures were Hippasus and Archytas, who established the relationship between the sound produced by metal discs according to their thickness, and by wires according to their length, and calculated the lengths that produced the main musical intervals (octave, fifth and fourth). **Philolaus** specified the notes of the scale by defining the major fifth and the major fourth, as well as the composition of the octave (five tones and two semi-tones), thus laying the foundation for modern music.

In biology, the ideas of the Pythagoreans were strongly marked by their dualist thinking. Through metempsychosis, a soul could inhabit any body, implying that there are souls in residence everywhere in the world. **Aristotle** reports that the disciples of **Pythagoras** thought the rays of the sun were alive and that one could actually see the movement of souls in the shining spots that dart here and there in sunlight, even when there is no wind. The air was full of souls, influencing our dreams and our actions, and warning of the future through premonitions. The Pythagoreans were also concerned with a number of medical questions, and long before the school of **Hippocrates of Cos**, it was a man from western Greece, **Alcmaeon of Croton**, who created the first real medical school in Greece, around 500 BCE. He studied the foundations of sensory perception and made numerous anatomical observations. He is even said to have been the first to have dared carry out a radical excision of the eyeball. But his most fundamental contribution was to recognise the brain as the seat of all sensations. It received signals from the ears (whose hollow structure enabled sounds to be concentrated), from the eyes (which transmitted light via filaments that conducted Fire to the centre of the brain), from the nose, tongue and all the rest of the body. These various signals were conducted along appropriate pathways and arranged by the brain into a harmonious structure, and it was this ability to bring sensations together to form a whole that made the brain the seat of thought. Memory and faith (not based on reason), were

made up of stored perceptions, and when memories were stabilised they formed knowledge (16). Alcmaeon also distinguished intelligence as the ability to organise sensations, and attributed it to humans alone, while other living beings had only sensory perception and were not capable of understanding.

The fundamental role he gave to the brain led him to study embryogenesis in respect of the formation of the head, which he thought was formed first. His experimental material was birds' eggs, and he believed in the female origin of all offspring, in

contrast to the generally accepted opinion which attributed it to the male semen. For **Alcmaeon** (as reported in a fragment of the doxographical tradition), all tissue was made up of opposite qualities (more of them than in the most orthodox Pythagorean tradition):

Alcmaeon said that the equality ἰσωνομία  (*isonomia*) of the powers (wet, dry, cold, hot, bitter, sweet, etc.) maintains health but that monarchy among them produces disease. [...] Alcmaeon thought that disease arose because of an excess of heat or cold, which in turn arose because of an excess or deficiency in nutrition. Disease is said to arise in the blood, the marrow or the brain. It can also be caused by external factors such as the water, the locality, toil, or violence.

Many other Pythagoreans were interested in biology, but only a few slim fragments of their thought have survived. **Menestor** used the theory of opposites to develop a study of botany, including germination, fructification and the role of the plant's

environment. And just as **Empedocles** did for the animal kingdom, he used the idea of a process of dissolution ($\sigma\eta\psi\iota\varsigma$ , *sepsis*) to explain the taste of vegetables. **Hippo** tried to explain biological cycles in terms of the number 7, and **Philolaus**, unlike **Alcmaeon**, explained disease as resulting from an excess of certain fluids found throughout the body, such as bile.

Finally, Archytas attempted to explain biological form in terms of intrinsic mathematical properties (17). Why were the parts of vegetables and animals usually rounded, rather than triangular or polygonal? Archytas explained this through natural movement, in other words movement that respects all constraints equally, as was observed, for instance, in the uniform rotation of a triangle around one of its sides, describing a cone. Following the constraints of symmetry generated rounded surfaces.

This idea may have been suggested by the way trees grow in concentric rings. In the same way, the human trunk was thought to be made up of concentric layers. We can note here an analogy between this imagery and the structure of the Pythagorean Universe.

The disciples of Pythagoras spoke in the name of a truth expressed through Number. Other contemporaries of theirs claimed to represent the truth in other ways, and we shall look at them next.

1: Matter and soul are absolute opposites, as with the dualistic Asian gods. ([back to text](#))

2: This was proven by the memory of past events that some people have, even of events before their birth. Like all properties of the Universe, this was subject to numerical or arithmetical laws. Some even made the calculation: the transmigration of souls took six years. ([back to text](#))

3: In this ideal upbringing, all the phases of human development from conception to adulthood are considered to be crucially important. While stockbreeders pay enormous attention to the way their animals are reared, people seem to give little importance to such problems in the case of their own offspring. Whereas in fact they should pay constant attention to the way their children are brought up. For instance, sexual relations should begin late (after the age of 20 for young men) and should go together with the harmonious development of the body and intellectual knowledge. Boys and girls should learn self-control through a life of hard work, avoiding all excess. And since all passion is incompatible with acquiring supreme knowledge, it goes without saying that the sole aim of sex should be procreation, and should be restricted to those who are capable of bringing up their children, for aimless procreation without a proper upbringing for the resulting children is the origin of Evil. Children should be taught the rules of best behaviour very early, together with the first rudiments of knowledge (reading and writing); young men should learn the laws of the State; adults should undertake active work and public service; and the old, who have theoretical knowledge and good judgement, are able to give good advice. However the time at which these various dispositions appear should not be considered as fixed for all, but should in reality be correlated with the harmonious development of the personality. Adolescence is the most difficult period, and requires a great deal of attention, to correct the mistakes of childhood (which are not faults!) and those of maturity, especially passions that are too strong. Violence must never be used, and even verbal violence must be avoided. In any case, good behaviour is the ideal of love, beauty and knowledge – the only possessions worth having, despite what the thoughtless believe. ([back to text](#))

4: $\delta\iota\omicron\ \mu\alpha\lambda\lambda\omicron\iota\ \phi\alpha\sigma\iota\ \tau\omega\upsilon\ \sigma\omicron\phi\omega\upsilon\ \omicron\iota\ \mu\epsilon\upsilon\ \acute{\alpha}\rho\mu\omicron\nu\iota\alpha\upsilon\ \epsilon\iota\upsilon\alpha\iota\ \tau\eta\upsilon\ \psi\upsilon\chi\eta\upsilon\ \omicron\iota\ \delta\acute{\epsilon}\chi\epsilon\iota\upsilon\ \acute{\alpha}\rho\mu\omicron\nu\iota\alpha\upsilon$ 

Some believe soul and harmony to be the same thing, for others harmony (among other things) is a property of the soul. ([back to text](#))

5: This may seem very primitive to us, but is it really so far distant from the recent enthusiasm for crude analogies that mask reality and try to explain everything in terms of "catastrophes", or even more crudely, "dissipative structures"? ([back to text](#))

6: The main characteristic of $\Gamma\nu\omega\mu\omicron\nu$ (the Gnomon) seems to be the presence of a right angle (the same issue that led to **Pythagoras'** theorem), together with the recurrence that enables the same form to be preserved through successive homothetic transformations, adding a "set square" shape to each new figure. Given these factors, $\Gamma\nu\omega\mu\omicron\nu$ was probably an instrument, perhaps a set square, used for plotting land and in architecture. ([back to text](#))

7: This explanatory analogy was taken up at length by **Plato** in *Timaeus*. It has also been used as a theme in modern analogies such as those developed by René Thom in his catastrophe theory. ([back to text](#))

8: The first two are well known. A harmonic progression would be 1, 1/3, 1/5, 1/7, and so on. The harmonic mean takes its name from the fact that it produces the three main musical intervals formed by notes produced by strings whose lengths are in a ratio of 6:3 = 2:1 (octave); 6:4 = 3:2 (fifth); 4:3 (fourth). ([back to text](#))

9: **Philolaus** chose not the Dyad but the Decad as the principle that produced the Unlimited. This choice reflected a very long eastern tradition that had led the sect to use the Tetractys as its symbol, and also to conceive the world in terms of ten pairs of opposites. **Philolaus** justified this choice through an anthropological argument, as reported in fragment DK A13, commenting that not only the Greeks but all nations were descended from the Decad 10 in their creation systems. ([back to text](#))

that not only the Greeks but all nations gave a special role to the figure 10 in their counting systems. ([back to text](#))

10: Further evidence of the major importance of the Decad: a tetrahedron has four faces and six sides, adding up to ten. ([back to text](#))

11: This makes geometry the queen of sciences:

γεωμετρία ἀρχὴ καὶ μητροπολις ... τῶν ἄλλων [μαθηματικῶν]. ([back to text](#))

12: Note the intense interest in the possible discovery of a tenth planet. ([back to text](#))

13: Only 125 years ago, in his *Popular Astronomy* (*Astronomie Populaire*) Camille Flammarion imagined beings living on the moon. And if Orson Welles is to be believed, Martians landed on Earth in 1938. ([back to text](#))

14: A solar year is now given as 365 days 5 hours 48 minutes and 46 seconds. ([back to text](#))

15: This kind of 'improvement', which consists in distorting reality to make it fit a theoretical model, which is seen as "intuitive" or "revealed", is still a powerful driving force. We will see endless examples of it. ([back to text](#))

16: "Then I will tell you, said Socrates. When I was young, Cebes, I had a prodigious desire to know that department of philosophy which is called Natural Science; this appeared to me to have lofty aims, as being the science which has to do with the causes of things, and which teaches why a thing is, and is created and destroyed; and I was always agitating myself with the consideration of such questions as these: Is the growth of animals the result of some decay which the hot and cold principle contracts, as some have said? Is the blood the element with which we think, or the air, or the fire? or perhaps nothing of this sort – but the brain (ἐγκεφαλον) may be the originating power of the perceptions of hearing and sight and smell, and memory (μνήμη) and opinion (δόξα) may come from them, and science may be based on memory and opinion when no longer in motion, but at rest." Plato, *Phaedo* 96 a-b; translated by Benjamin Jowett (1871) ([back to text](#))

17: Here we come back to a question that has always haunted the best mathematicians – and **Archytas** was certainly a great mathematician – as can be seen today in the work of René Thom or his imitators. Diels, H. and W. Kranz, 1952, *Die Fragmente der Vorsokratiker* (in three volumes), 6th edition, Dublin and Zürich: Weidmann. ([back to text](#))

Third chapter: visionaries