

To Read God's Mind

Pythagoreans & the Birth of Science

"This is not the way things were supposed to go," thought Plato. As he squatted in the fetid belly of a cargo ship, iron chains rubbed his wrists and ankles raw.

Just a few weeks ago, he had been warmly greeted by leading citizens of Tarentum and other rich cities of Magna Graecia. Heated discussions and drinking bouts long into the night, leisurely walks in lush orchards seemed to cement friendships with cultivated Greeks from the colonies, whose sons brought back trophies from the Isthmian Games while their horses triumphed at the Olympiads.

What had derailed those halcyon days? Hadn't Archytas welcomed Plato into his home? Archytas, who had been proclaimed *strategos* seven times by the citizens of Tarentum even though the city laws forbade any man from serving as general more than once, from fear of power going to his head? Wasn't Archytas one of the most prominent Pythagoreans of the age, who reportedly solved the puzzle posed by the Oracle of Delphi {"Double the altar of Apollo – a cube."}, thus saving Delos from the plague?

But then had come Dion, from the island of Sicily, singing the praises of Dionysus, the ruler of the city of Syracuse. Dion promised that Dionysus would heap honors on the philosopher from Athens and would eagerly listen to his every word. But the young tyrant had a short attention span, and at a banquet, he called Plato a doddering old fool. Plato retorted

that he was but an uneducated bully. Mutual friends separated the two, and at first it looked as if matters had been settled amicably. But the seeds of enmity had found root, and Dionysus conspired with the ambassador from Sparta. Traveling on the same ship as Plato, once at sea, the Spartan had Plato cast into chains, to be sold into slavery.

As soon as the Pythagoreans heard of this treachery, they dispatched a rescue party to buy Plato's freedom. As a philosopher, Plato was greatly animated by the notion of Justice, and his sense of justice would surely dictate that he owed the Pythagoreans not just coins, but deep gratitude. Yet in Plato's voluminous works, across dozens of dialogues, we find the Pythagoreans mentioned just a handful of times. What the...?!

But this seeming ingratitude points to a little-known facet of a complicated relationship: Plato had obviously been initiated into the Pythagorean brotherhood, and members who revealed the secret teachings were ostracized and banished from memory. All Plato could do was invent myths and bury the secrets in there.

Later generations would point a finger and accuse: "Plato Pythagorizes...!" Already Aristotle, Plato's own disciple, lumped Plato with the Pythagoreans.

The Pythagoreans say that things exist by 'imitation' of numbers, but Plato, by 'participation,' but these are the same, and Plato only changed the name. – Aristotle

Everything is Number. That was the great leap of the Pythagoreans, that everything could be measured and quantified. That was the birth of science, where repeated experiments yield predictably measurable results.

Another link to the brotherhood can be found in Plato's most Pythagorean text, *Timaeus*, where the Demiurge creates the cosmos according to ratio and number. When describing the planetary system, Plato invokes the celestial music of the Pythagoreans.

**Up above the rim of each circle sat a Siren, singing one pure note. And the music of the different spheres gave one harmony.
– Plato, *Timaeus***

The harmony of the Sirens could be found in a Pythagorean *akousma*, a *koan*-like riddle that only those from the inner circle could explain.

Q: What is the Oracle at Delphi?

A: The Tetraktys that gives the Harmony of the Sirens

The Oracle of Delphi is the oracle of Apollo, the Sun god whose seven-string lyre leads the dance of the celestial Wanderers, the seven Planets. What is the Harmony of the Sirens? It's the celestial music the Planets produce as they revolve in their orbits.



The Tripod of the Oracle of Delphi on a incuse silver stater of Croton, from the lifetime of Pythagoras.

How does the Tetraktys link these diverse elements together? When the Pythagoreans had to swear an oath, they would call upon this pyramid of pebbles, one at the top, two in the next row, three in the third, and four in the bottom row.

Pythagorean Oath: “By he who gave our souls the Tetraktys.”

The true beauty of the Tetraktys jumps out when the whole-number ratios embedded in it reveal the foundations of Western music, an encyclopedia written with 10 little stones.



Pythagoras portrayed in Raphael's *School of Athens*, in the Vatican. By his left foot, a chalkboard shows the Tetraktys.

The two top rows, the singleton and the next row of two pebbles, give the ratio of 1:2, the musical interval of the Octave, the universal basis of music. The two middle rows give the ratio of 2:3, the musical interval of the Fifth, the next most consonant interval of the musical scale. And the bottom two rows spit out the ratio of 3:4, the musical interval of the Fourth, completing the canon and providing all that's necessary to develop a mathematical theory of music.

If you add the interval of the Fourth to the interval of the Fifth, you get a perfect Octave, the Tetraktys itself. If you subtract the Fourth from the Fifth, you get a whole note, the basic unit of the musical scale. According to the myth, Pythagoras discovered these musical intervals when he walked by the ringing shop of a smith, whose pounding hammers beat out different tones on metal bars of varying length.

Pythagoras moved on to string theory, building a monochord that showed that filaments of differing lengths gave intervals of mathematically predictable notes, with the pitch measurably related to the length of the string. In his investigations, Pythagoras came upon an astonishing fact that still bears his name.

No, it's not the Pythagorean Theorem, which every schoolchild hears described these days, but with little elucidation about Pythagoras. Rarely is it mentioned that Plato proclaimed his allegiance to the Pythagoreans with the motto engraved at the entrance to his Academy.

“Let no one ignorant of Geometry enter here.”

Yes, the Pythagoreans and Plato's Academy both demanded a basic grasp of logic, which was best provided by geometry and mathematics. Numbers were held in such high regard that they sometimes acquired almost mystical properties.

“Seven is the key to the universe,” wrote Cicero in the *Dream of Scipio*, and he dedicated his translation of Plato's *Timaeus* to his Pythagorean mentor, Nigidius Figulus. Divide the number 1 by the numerals from 2 to 9, if you wish to divine Cicero's secret — even Isaac Newton wouldn't let go of this esoteric viewpoint.



South Italian wine-drinking kylix with a Pythagorean motif of seven leaves.

But it was music and astronomy that were reserved for the highest echelons of investigation. In astronomy, the seven Wanderers mirrored the seven notes of the musical Octave, giving the celestial harmony of the Sirens and suggesting that these widely different branches of learning were in fact sister sciences.

In music, Pythagoras noted that a cycle of seven octaves matches a cycle of twelve fifths almost exactly. Almost, but not exactly... The small difference is called the Comma of Pythagoras, a seal that proves the presence of the Pythagoreans at the birth of modern science.

The cycling of fifths through octaves produces each and every halftone of the musical scale, the 12 halftones marked out by the 12 fifths that revolve through seven octaves. In his book on music theory, Michael Pilhofer (MM), writes:

“The creation and use of the Circle of Fifths is the very foundation of modern Western music theory...”

Ahhh... Not just the foundation of *modern* music theory, but music theory going all the way back to Pythagoras, who stands at the beginning of the long corridor of time, holding a torch to illumine this dark path.

So important was the cycling of fifths through octaves to the Pythagoreans that they encoded it into something that people use every day, yet whose origins remain shrouded in oblivion. Each day, as you wake up, bring to mind the days of the Week that reflect the musical Circle of Fifths that cycles through the Octave, the seven days that are named after the seven Planets.

Moon day (Monday) is the first step up the planetary ladder, as told by Plato, Vitruvius, Martianus Capella, etc. From there, an interval of a fifth (skipping three Planets) lands us at Mars, the French Mardi. Another fifth circling around brings us to Mercredi, the day of Mercury. A further leap gives us Jeudi, or Jove/Jupiter day, and then we arrive at Vendredi, the day of Venus. One more hop brings us to Saturn (Saturday), and finally we rest on Sunday. The next day, we start the week all over again, pushing the boulder up the hill, just like Sisyphus.

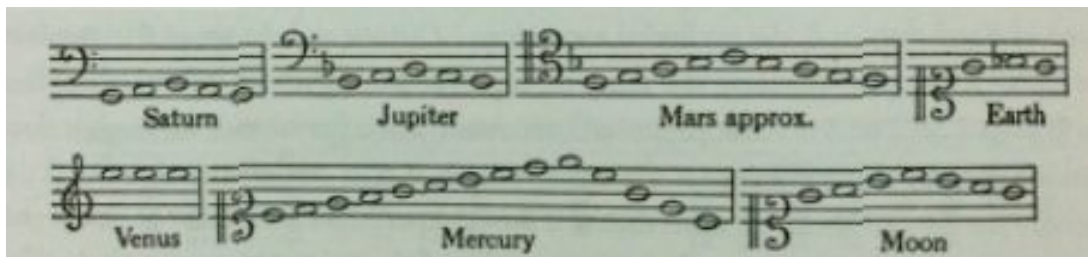
The Pythagorean Music of the Spheres was the grand unifying theory of the ancient world, and Pythagorean thought would inspire those who opened the floodgates of modern science thousands of years later.

In *Standing On The Shoulders of Giants*, physicist and mathematician Stephen Hawking compiled the scientific works that most impacted Western scientific thinking. The authors he chose: Copernicus, Galileo, Kepler, Newton, and Einstein.

Who inspired the revolutionary vision of the heliocentric planetary system? According to Copernicus, it was Hicetas and Ecphantus of Syracuse, Pythagorean scholars from Sicily.

Johannes Kepler would be bounced by fortune from posts as a simple mathematics professor to highly regarded astronomical scientist. Tycho Brahe hired him as his lieutenant, to aid in the meticulous observations of the movements of the planets. When Brahe died, Kepler got his hands on jealously guarded data that had tracked the motion of Mars for decades, providing concrete numerical evidence for Kepler's Third Law of Planetary Motion.

Where did Kepler look for inspiration for his theories of planetary motion? First he tried the geometric model of the Platonic solids, but that did not prove entirely tractable. Digging further back to the Pythagoreans, Kepler found the Harmony of the Sirens that would yield his masterpiece, *Harmonice Mundi*, where Kepler still describes the orbits of the Planets in musical terms.



Kepler's Harmony of the Planets in *Harmonice Mundi*

Hoping for assistance from the spirit of Pythagoras, Kepler mused that perhaps "the soul of Pythagoras has migrated into me." Through the prism of Pythagorean Number, Kepler laid the foundations of the Space Age, and his Laws of Planetary Motion are still used today to calculate the trajectory of rockets and interplanetary satellites.

Isaac Newton would build on Kepler's work to march us into the modern age, but even he retained a fondness for the symmetry inherent in Pythagorean thought. With a glass prism, he broke up a ray of white light into its components: red, orange, yellow, green, blue, and violet. But these are only six colors. For order to be maintained, Newton had to insert a

seventh color. That's how we got indigo, a color that does not exist independently in the spectrum, but which was necessary, in Newton's mind, to maintain the Pythagorean symmetries: Seven notes in the octave, seven Wanderers in the sky, seven colors in a ray of light, Cicero's cosmic seven that revealed the thoughts of God.

As mankind continues to explore interplanetary space, we keep stumbling upon harmonic intervals and geometric patterns. Neptune and Pluto exhibit a 2:3 orbital resonance, while the Lagrange points between celestial bodies adhere to precise geometric alignments.

The Pythagoreans would be delighted.

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