A Plant[1]

Following your topographic maps of a forested region in northern Idaho, you've come to a grassy meadow. It'll be a good place to rest. The heavy backpack is taken off and the soft grasses make a good bed. As fingers slide through the blades of grass, they come upon the plant. It's plucked from the ground, roots attached and held close for viewing.

The stem is 18 inches in length and is dense with scarlet colored clusters of bracts and leaves. At the tip of the stem is a tubular-shaped, yellowish-green flower, one inch in length. Examination of its roots indicates that they have not only penetrated the soil for water and nutrients such as nitrogen, but also the root tissues of the surrounding sagebrush. The plant is a semiparasitic, dependent on other plants for a portion of its nutrients. Yet, through photosynthesis, this plant helps provide what is essential for the life of others, what others depend upon. Utilizing radiant energy and soil nutrients, the chlorophyll in its cells manufactures carbohydrates from carbon dioxide and water to release the oxygen you're now breathing. It is *Castilleja linarieaefolia* Benth., Indian Paintbrush, representing one of over 250,000 species of Angiosperms.

After a reading of the compass and a review of the map, the backpack is put on and the hike continues.

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[1]For additional background, see Barfield 1957, Bronowski 1973, Hall 1983, Matthews 1978 and Nasr 1968.

Walking past the village blacksmith's shop, the pleasant ring of hammers striking an anvil catches your attention. It's music in harmony. Going into the shop, you find that the lower notes that you hear are produced by heavy hammers, while the higher notes are caused by lighter hammers striking on the anvil. As you've observed from the strings of a musical instrument, the objects creating the sounds can be broken down into discrete, mathematical units. Each of these units, when paired with another that has been divided into exact parts of two, three or four, will produce a harmonious sound. A string is stretched tight and plucked. A sound, a note, is heard. A second string, exactly half as long as the first, is stretched along side the first and plucked. The sound of the note is an octave above the first note. A third string, exactly one third as long as the first, is stretched and plucked. The sound is a fifth above the first. It's all harmony to your ears. But when the second and third strings are shortened or lengthened, if only slightly, the plucked sound is discordant. The world of sound is governed by a universal and all pervading mathematics, numbers in balance and harmony.

You are Pythagoras (580-497 B.C.), and what you assert for the world of sound you assert for all of the world. The world of shapes and forms are governed by a harmony of exact numbers. Knowledge of this fundamental relationship between the world of space and mathematics leads you, Pythagoras, to a critical discovery.

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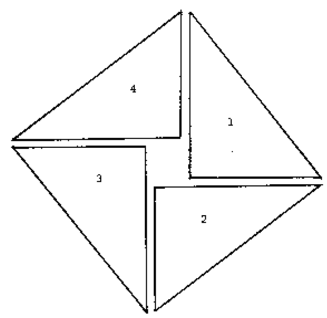
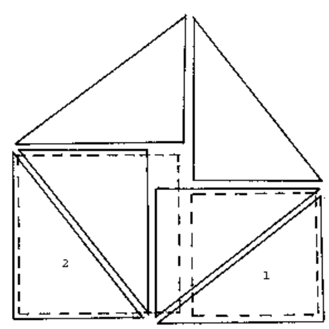
Let us replicate in our own experience what Pythagoras discovered in the 6th century B.C. We'll begin with the assumption that gravity is vertical and that horizontal stands at a right angle to it. The conjunction of the vertical and the horizontal fixes a right angle. Following Pythagoras, this basic spatial relationship is to be found



throughout all of nature. From this assumption a most important observation and subsequent application can be made. An experiment will demonstrate.

Take a right angle and cut it out from a piece of paper in the form of a triangle. Lay it down on another piece of paper, and with the side opposite the right angle facing out, move it down and sideways four times. As the triangle is moved, place the sides of the right angle against each other. Draw a line completely around the sides of the triangle. After moving the right angle four times, the triangle should rest at its original starting place. A square is formed if the hypotenuse of the right angle is kept on the outside as it is moved, i.e., a square of the hypotenuse. Only a right angle can do this.



Because of the right angle, two other squares can be formed from the movement of the same triangle. On the same piece of paper that the previous square was drawn, place the hypotenuse of the triangle against the outside of the square. Draw a line along the sides of the right angle. Now place the triangle on the outside of the adjacent side of the square, again with the hypotenuse against the square. Draw around the sides of the right angle of the triangle. Each of the two sides of the right angle should mark out each of two separate squares, though each smaller than the original square.

From this experiment and with these observations, a general theorem can be stated for every triangle that contains a right angle: the square on the hypotenuse is equal to the square on one of the other sides plus the square of the other. This is true, if and only if, the angle they contain is a right angle. Of course, this is the Pythagorean theorem, i.e., a right angle is the square of the hypotenuse equal to the sum of the squares on the other two sides.

The test of the theorem offers proof of its validity. If a triangle is 5 inches by 4 inches by 3 inches, for instance, is it a right angle? Five inches is the hypotenuse and squared it is 25. Four inches squared is 16, and three inches squared is 9. The sum of these two squares is equal to the square of the hypotenuse, i.e., 25. The triangle contains a right angle, and our theorem has validity based upon this test.

$$a^2 + b^2 = c^2$$

For Pythagoras, the world of space is governed by exact numbers. Within nature and throughout the cosmos, numbers organize the forms, structures and dimensions of all being into a *harmonium*, "harmony." As with the music of a properly stringed instrument, the parts of the cosmos "vibrate" in harmony. In turn, particular combinations of numbers have greater significance for Pythagoras. One such combination is the *tetractys*, "source and root of everlasting nature," a triangle made up of ten dots. The number ten is consequently a sacred number. Another combination is the number four, which represents "justice."

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This is not to suggest that all is in harmony. Much of the physical world as well as our own bodies are discordant and unbalanced. In fact, the soul is condemned to a cycle of purgings in Hades and rebirths as a prisoner of the physical body. It is for this reason that Pythagoras abstained from consuming the meat of an animal. The soul of a relative could be within.

But as pure mathematical patterns are apprehended through observation and disciplined mediation by humanity, humanity can then apply these universal principles to bring order to the world and thereby redeem the self and the soul. Once harmony between one's soul and the cosmos is obtained, the soul ceases the cycles of reincarnation into varied material forms and becomes forever part of the singular divine cosmos.

While the sacred connotation of numbers has been discarded over the centuries, the monumental significance of Pythagoras's discovery of the relationship of discrete numbers to the patterns of the world continues to reverberate. As was subsequently echoed by Galileo and, later, Jacob Bronowski (1973), a contemporary philosopher of science, "the language of nature is mathematics." With this fundamental knowledge of the structure and workings of the world, geometry and physics became a science. The Doric temple of Parthenon and the Sears Building in Chicago could be built. A man could walk on the moon. With this knowledge our modern world came into being.

Extensions

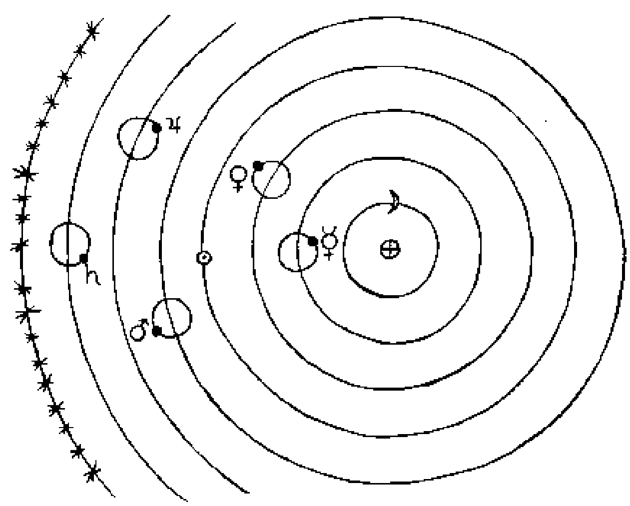
Geocentric Cosmos

In 150 A.D., Claudius Ptolemy applied a geometric model to the heavens. Spheres and perfect circles formed the basis of his hypothesis of the planetary movements in a geocentric cosmology.

In the center of the cosmos is the Earth, in a state of rest, inclusive of both man and god. Out from the divine center, the Moon rotates in a perfect circle around the Earth. Next out is Mercury, which rotates in an epicycle, a circular rotation whose center forms the circumference that in turn circles the earth. Venus is next out, also with its own circular orbit that circles the earth. Then comes the Sun, with a simple rotation around the earth. Mars, Jupiter and Saturn follow. The finite universe is bounded by the Stars, fixed in stationary positions. As with the center of the cosmos, spirit emanates throughout all the universe, within all the celestial bodies. The driving force of each planet's rotation through the cosmos is, in fact, its soul.

Based on the principles of geometry, the Ptolemaic theory is a complex model. But it works, more or less. The appearances are accounted for, and the essences are given meaning. All of the cosmos, god and man, has its place.

The Ptolemaic Cosmos



Ptolemy wrote down his hypothesis in a thirteen-volume book, *Almagest* (Syntaxis mathematica). Translated into Arabic in the 9th century, it was a standard reference work on issues of astronomy until the 16th century, for both European and Islamic astronomers.

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From the hill overlooking the village, you look out into the heavens. Your view is crisp and clear. In the dark of the night, the Planets shine bright...and You shine bright, perfect souls in perfect orbits in perfect harmony.

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In 1413, the first Spanish ships began raiding the coast of West Africa, taking cargo and capturing slaves from Arab traders. This was now possible because of the knowledge a new technology brought. The compass and sextant made distant navigation possible. The world was being very closely observed, and some people greatly benefitted from this new knowledge.

Heliocentric Universe

The Roman Catholic Pope asked a distinguished churchman and intellectual from Poland to reform the rather complex calendar. His name was Nicolaus Copernicus (1473-1543). Copernicus investigated an idea, first proposed in the 3rd century B.C., that placed the sun right in the middle of the universe, with the earth rotating around it. This heliocentric system was based on a much more mathematically rigorous explanation. Man was no longer the center of the cosmos. At the age of seventy, Copernicus reluctantly published his research, *The Revolution of the Heavenly Orbs*.

The Church

In 1517, the Protestant Reformation began. The authority of the Roman Catholic Church was being seriously challenged. After much struggle, Rome would no longer be the primary interpreter and disseminator of theological knowledge. The Reformation affirmed everyone's right to interpret for him or herself. In time, authority would be with the individual, not just the clergy.

Proven Facts

Two great men were born in the year 1564. They were William Shakespeare in England and Galileo Galilei in Italy. Each would have quite differing but very significant influences.

In 1609, Galileo perfected an instrument for making distant objects appear larger, as if close at hand. His telescope allowed him to observe what human eyes had never before seen, e.g., sun spots and Jupiter's moons. He also improved upon the compound microscope, making minute objects appear larger. The natural world was not only being seen, but being seen in new ways.

Galileo further refined the model of the Copernican heliocentric universe and fully articulated an entirely new way of knowing the world. Based upon his observations and his theories, Galileo maintained that the universe was a physical universe and that the Copernican universe was "proven fact," the truth and the only true theory of the physical universe.

It was these assertions that got Galileo into trouble with the Cardinals of the Roman Catholic Church. He was confined to his villa and found it difficult to publish his research. The Church did not so much object to his theory of a heliocentric cosmos. They in fact encouraged all theories. What the Church objected to was a theory that maintained that all other theories were wrong and that there was no place for a divine center in the cosmos nor of a divine presence of any kind.

Prior to Galileo, all theory was understood as hypothesis, as assumptions about the appearances of the cosmos. Most critically, theory sought to account for the essences, the inner forms behind those appearances. It did not necessarily attempt to describe the overt and material expressions of the world. Theory was an analogy, and not a literal representation of the cosmos; and it was a proposition that could accommodate differing propositions. The theory of Ptolemy was such a theory, a theory that "saved the appearances." It was a theory that emanated out of a Platonic world view.

Galileo, however, offered a new theory on the nature of theory, a new epistemology. A Platonic view of the world was no longer possible. In 1632, his research was finally published (in Switzerland), *Dialogues Concerning the Two Chief World Systems*, followed in 1638 (in Holland) by *The New Science*.

Laws of Nature

Isaac Newton (1642-1727) offered a new theory of inertia. He schooled himself in mathematics, later inventing what is now called calculus. His conception of the universe was published in 1687, the *Principia* (*Mathematical Principles of Natural Philosophy*), and described an orderly world subsumed under a single set of laws. Following the observations suggested by Galileo, Newton's First Law of Motion states that an object at rest will remain stationary unless acted upon by some outside force, and an object in motion will continue in motion in a straight line and at a constant velocity, unless acted upon by some outside force.

The Second Law of Motion states that the acceleration of an object is directly related to the force exerted upon the object. The more force exerted, the faster the object moves. The less force exerted, the slower the object moves. And the acceleration of an object is inversely related to the mass of the object. The force exerted on an object of large mass will result in less acceleration than the same force exerted upon an object of smaller mass.

The Third Law of Motion states that for every action there is an equal and opposite reaction. No force may be exerted upon any body that does not affect a second body. From these universal laws of gravitation, Newton calculated the movement of the planets around the sun as well as the movement of an apple from a tree. The gravitational pull of the sun or the earth is inversely proportional to the square of a planet's or an apple's distance from the sun or the earth.

What applies in the solar system applies in one's back yard.

For the first time in human history, a concise and rigorous theory was proposed that maintained that the physical universe can continue movement indefinitely without an animate or a divine power regulating it. The universe is an orderly and predictable universe, governed by great mechanical forces. These forces are implicit within the autonomous laws of the universe, laws that are as absolute as that which they govern, i.e., space and time. And these are laws that are knowable by man, to be observed and used by man.

Wilderness

"A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Wilderness Act, Act of September 3, 1964 (P.L. 88-577, 78 Stat. 890; 16 U.S.C. 1121 (note). 1131-1136).