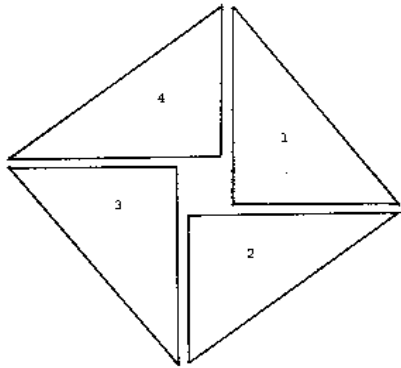# Pythagoras and the Language of Nature

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
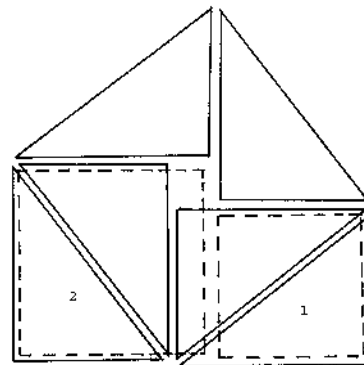
completely around the sides of the triangle. After moving the right angle four times, the triangle should rest at its original starting place. A square is formed if the hypotenuse of the right angle is kept on the outside as it is moved, i.e., a square of the hypotenuse. Only a right angle can do this.

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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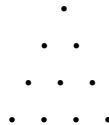
This is not to suggest that all is in harmony. Much of the physical world as well as our own bodies are discordant and unbalanced. In fact, the soul is condemned to a cycle of purgings in Hades and rebirths as a prisoner of the physical body. It is for this reason that

Pythagoras abstained from consuming the meat of an animal. The soul of a relative could be within.
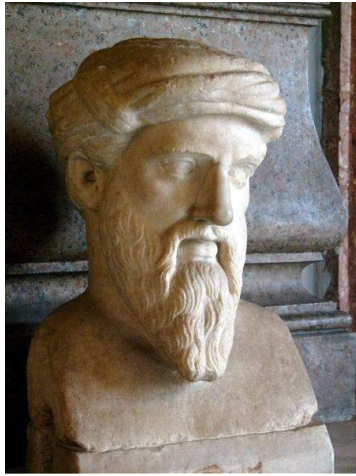
But as pure mathematical patterns are apprehended through observation and disciplined mediation by humanity, humanity can then apply these universal principles to bring order to the world and thereby redeem the self and the soul. Once harmony between one's soul and the cosmos is obtained, the soul ceases 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 natural 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.

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