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THE BIG FOUR

Vladica Ristić[1]

Abstract

In this paper the four greatest scientists so called “The Big Four” are selected as those among the scientist who changed the human knowledge and our planet in terms of innovation, science and philosophy. Namely, the paper is about Pythagoras, Archimedes, Muhammad ibn Musa al-Khwarizmi and Ruđer Josip Bošković – Ruggerio di Raguzeo, the founders of a numerous new sciences and sub-sciences, such as Fluid Mechanics, Hydrotechnics, Static, Geodesy, Algebra, Spherical Geometry with Mathematics and Quantum Physics. Pythagoras is an ancient mathematician, scientist, astronomer and philosopher, the founder of a philosophical, mathematical, mystical and scientific society or community, which is known as the Pythagorean School. Archimedes was an ancient mathematician, physicist and astronomer. Although not much information is known about his life, he is considered the greatest mathematician of antiquity, and one of the greatest scientists till today. Muhammad ibn Musa al-Khwarizmi often referred to as simply al-Khwarizmi, was a polymath who produced vastly influential Arabic-language works in mathematics, astronomy, and geography. Ruđer Josip Bošković – Ruggerio di Raguzeo was a mathematician, astronomer, surveyor, physicist and philosopher. In the paper their contribution to the development of innovation, science and philosophy is analysed. Their influence on other famous scientists, innovators and philosophers has been discussed.

Key words: *Scientists, innovators, philosophers, four founders of new sciences and sub-sciences, impacts on human knowledge and development till today.*

Introduction

This paper deals with the history of science, that is, of scientists. To know who the fathers of science are, we have to go back to the distant past. The past of science is also the future.

Why the big four? Who makes up the big four? What are the criteria for choosing the big four? Questions to which I will try to give answers in the paper.

The Big Four is just a way of expressing the four most important scientists, in my opinion, who created the world as we know it.

The big four in my opinion are:

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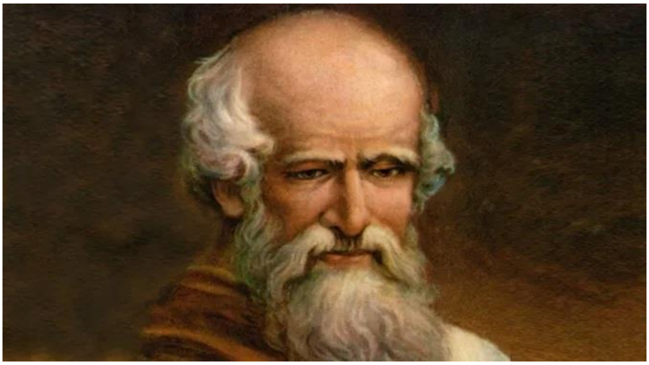
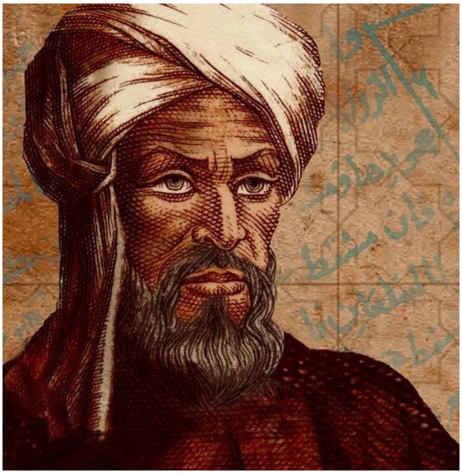
- Pythagoras

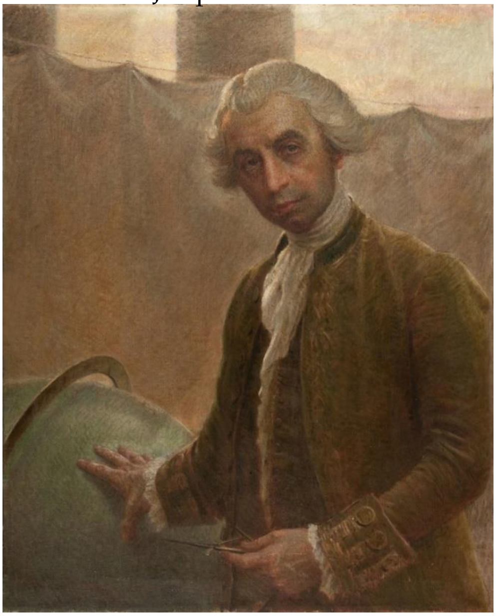
- Archimedes



- Muhammad ibn Musa al-Khwarizmi



❖ Josip Ruđer Bošković



The criteria by which I chose the big four are as follows:

- They laid the foundations of new sciences
- Original ideas and inventions that everyone else refined
- Way and methodology of work, in the explanation of new sciences
- Application of new sciences
- In the sciences, time is counted to and from them

Pythagoras

The legend of Pythagoras has been greatly glorified and embellished, his name has been associated with so many endeavors and concrete discoveries, with countless mystical beliefs and supernatural endeavors that it raises the question: did this person of obscenity, mathematician and political reformer really exist. However, the life of the historical Pythagoras can be cleared of the legend woven around his name. Today, it is considered that his influence on the development of human culture and society, especially in the West, is enormous.

It is accepted that Pythagoras was born in 569 BC, although there are sources that decisively claim that he was born in 580 BC. As a child, he spent his early years in Samos but traveled a lot with his father.

Pythagoras was the third child of his father, Min-Sarus, translated into Greek Mnesarchus from Tire (Lebanon), a prominent merchant of the time, and his mother, Pythia, who was from Samos. There is a story that during a great famine, father Pythagoras gave Samos grain, and in return he received the citizenship of Samos. I would like to make a small digression here. I would like us to always be aware that, according to his father, and we will see later according to everything else, including his death, Pythagoras was not Greek. There is not the slightest indication that he ever stayed on the land now considered Greek, and as we shall see, it is not that he did not travel.

According to some reports, Mnesarchus returned with Pythagoras to Tire where Pythagoras was educated by Chaldeans (inhabitants of southern Iraq who briefly ruled Babylon) and learned men from Syria. Some believe that he also visited Italy. It can be said of Pythagoras that he was well educated, that he could play the lyre and that he could recite Homer.

At an early age, he was taught by three philosophers, among whom Ferikidis is considered his teacher. Two other philosophers who are believed to have first imparted the secrets of mathematics to him, when he was between 18 and 20 years old, are Thales (who was very old at the time) and his student Anaximander, both from Miletus (a city in the extreme southwest Asia Minor, which was the closest city to Samos on the continent - across the strait)

It is believed that Anaximander gave him the first knowledge of geometry and cosmology, and that Thales advised him to travel to Egypt to learn much more. It is my opinion that the Miletus-Samos connection can be considered the first channel of transfer of all Eastern knowledge to Europe.

Around 535 BC, (so at the age of 34) Pythagoras went to Egypt. It is believed that the tyrant of Samos, Polykratis, with whom Pythagoras was friends, gave him a written recommendation for this trip. According to some sources, Pythagoras visited a large number of temples in Egypt, and according to Porphyry, he was only allowed access to the temple of Amun-Ra, known today by the Greek name of Diospolis in the area known today as Greek called Thebes (some consider it a city) where he was ordained and became a priest. It is believed that there he learned Vedic (Krishna) dogmas from Indian sages (gymnosophists - today yogis) and accepted some of their beliefs. in Egypt, was captured (the Persian-Egyptian War in which Polycrates sided with Persia) and as a prisoner of war was taken to Babylon where he was trained as a priest of the Magi. Here he learned their secret rites and learned about the highly mystical service of the god. There he also acquired the best knowledge of music, arithmetic and other mathematical knowledge possessed by the Babylonians. According to some sources, there he had contact with the Jewish religious diaspora that Nabucco brought after the destruction of Israel and Solomon's Temple. Despite all this, it is not clear how he could enjoy all these freedoms in captivity. He also tells stories that he isolated himself on Mount Carmel in Phoenicia. Traveling to Crete, Pythagoras studied the legal system there. From the point of view of this essay, his stay in Thrace (the territory that is today divided between Bulgaria, Turkey and Greece, with the capital Plovdiv) is also important.

This is how the Pythagorean Brotherhood was born, which soon grew to around 600 members who could not only understand what was preached, but also create new ideas. The brotherhood worked in closed meetings or rituals. However, a parallel activity took place within the school. Namely, in addition to the students of the so-called mathematician, a special class was organized for a larger gathering of about

2,000 citizens - "audiences" who, admittedly, could not see the Master since he was made of cloth. At these sessions, Pythagoras shared his immense experiences and knowledge about everything he had learned in the East.
The social concept that Pythagoras applied is reflected in advocating for the common use of goods (a new member immediately contributed all his property to the Brotherhood), and through meditating on a new revelation - through philosophy - in striving (through knowledge and love) to achieve inner harmony and agreement with Supreme Harmony. The basic beliefs of the Pythagorean Brotherhood are:

- That in its deepest basis reality is mathematical in nature,
- That philosophy can be used for spiritual purification,
- That the soul may rise to union with the divine,
- That some symbols have a mystical meaning and
- That all brothers in the Brotherhood must exercise strict loyalty and secrecy.

Pythagoras himself left no written trace, which is part of the application of the last rule. It is claimed that one of his students was drowned even after the death of Pythagoras, because he betrayed the secret of the construction of the dodecahedron.
The criteria for admission to the bartsvo were strict, so that there were seen Croton personalities who did not receive a white ballot. Ceylon is important among them.
There are several versions of the end of Pythagoras' life span, but I will mention only one here because it is characteristic of the Brotherhood.
For Pythagoras, it is important to note that he introduced the cult of personality into history. In the ritual, the very name of the "Master" was a secret and an obligation not to say it. It was forbidden to pronounce the name, so they called him: The One, The Immortal, The Genius, The Divine. It goes so far as to claim that he appropriated all the results of his students. He was considered a miracle worker of the highest rank. Herodotus himself, in the century that came after the death of Pythagoras, respectfully referred to him as "He Whom I Shall Not Name".

Impact on humanity

Unlike many later mathematicians, for whom we have at least one of the books they wrote, there are no written works of Pythagoras. The society he led was half scientific and half religious and followed the rules of secrecy that make Pythagoras mysterious to this day.
The roots of respect for him as such and his work, in my opinion, are related to the needs of modern Western society to find a creator of values on which it tries to (at least formally) rely.
Today, he is credited with making three very significant contributions to Western civilization.

- The first contribution refers to the transfer of an enormous amount of knowledge and understanding from the East to the West. The intellectual bridge he created actually launched the spiritual and scientific thought of the Western world. Rigor in the application of rules, whether canonical, social or scientific, made him a model of purity and justified every movement that followed him. In all 2,500 years after him, the greatest minds of human civilization have repeatedly admired and recognized the greatness of his contribution to Western thought.

- Another contribution relates to the coupling of nature and numbers. Having a musical background and being a mathematician, he noticed the connection between order in harmonic sound signals and fractions. It is an interesting story about how he came to this discovery by listening to the hammers in the forge and established a connection between the frequency of the sound produced by the impact of the hammer and it mass. He also attributed numbers to the order of the universe and he is credited with the word cosmos. Based on this, it is considered that he was the first to establish that natural phenomena obey laws that, again, can be expressed by formulas. With this, he established a link between modern physics and mathematics. He is credited with the realization that mathematics is the basis of every natural science.
- The third contribution concerns the method for discovering absolute truth that made him famous as the author of the theorem. He is considered to have laid the foundations of mathematics. It seems certain that he developed the idea of mathematical logic and that he is responsible for the first golden age of mathematics. Thanks to his genius, numbers were not only used for counting and calculations but became valued as such. He studied the properties of some special numbers, their mutual relationships and the structures they form. He realized that numbers exist independently of the everyday real world meaning that their study would be untainted by the uncertainty of the senses and human perception. This means that he could discover truths that are independent of personal attitudes and prejudices and that are absolute. He introduced the concept of mathematical proof and thus indicated the way to find mathematical truth which is universal and eternal and cannot be disproved forever. This is considered to be his greatest contribution to human civilization: a way to arrive at a truth beyond the fallibility of human reasoning.

Pythagorean Number Theory

Pythagorean Number Theory - There are two orders of numbers: odd and even. Because unity, or 1, always remains indivisible. So 9 is 4 + 1 + 4, with unity in the center. Moreover, if any odd number is divided into two parts, one part will always be odd and the other even. Thus, 9 can be 5 + 4, 3 + 6, 7 + 2 or 8 + 1. The Pythagoreans considered the odd number, whose prototype is the monad, to be distinctly masculine. Unity, or 1, was considered an androgynous (similar) number, and is therefore both even and odd. If added to an even, negative, number, then it produces an odd, positive, number. Adding it to odd makes it even. It turns male into female and vice versa. Change factor. Every even number can be divided into two equal parts which are always either both odd or both even. When 10 is divided into equal parts, we get 5 + 5, two odd numbers. The same principle applies if it is divided into unequal parts. For example. 6 + 4 where both are even, at 7 + 3 both are odd. With an even number, no matter how the parts are divided, there will always be either odd numbers or even

numbers. The Pythagoreans considered even numbers, the prototype of which is the duad, to be indefinite and feminine.
Odd numbers divided by a mathematical process called the Sieve of Eratosthenes fall into three general classes: prime, complex, and prime-complex. Prime numbers are those that have no divisor other than themselves and unity, such as 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, and so on. For example, number 7 is divisible only by 7, which is contained within itself, and unity, which goes into 7 seven times. Complex numbers are those that are divisible not only by itself and unity, but also by some other number: 9, 15, 21, 21, 25, 27, 33, 39, 45, 51, 57, and so on. 21 is divisible not only by itself and unity, but also by 3 and 7.Simple-compound are those that do not have a common divisor, although each can be divided individually. For example. 9 and 25. 9 is divisible by 3, and 25 by 5, but none of them is divisible by the divisor of the other. Since they have one divisor, they are called complex, but since they have no common divisor, they are called simple. Hence simple-complex.
Even numbers are also divided into three classes: superperfect, deficient, and perfect numbers.
Superperfect numbers are those in which the sum of their fractions is greater than themselves. For example 1/2 of 24 = 12, 1/4 = 6, 1/3 = 8, 1/6 = 4, 1/12 = 2, 1/24 = 1. The sum of all those parts (12 + 6 + 8 + 4 + 2 + 1) is 33, which is greater than 24, the original number.
Deficient numbers are those that are greater than the sum of their fractions. 1/2 of 14 = 7, 1/7 = 2, and 1/14 = 1. Which makes a total of 10.
Perfect numbers are those that are equal to the sum of their fractions. Such numbers are extremely rare. Only one is between 1 and 10, which is 6. One between 10 and 100, which is 28. One between 100 and 1,000, which is 496. One between 1,000 and 10,000, which is 8,128. It is interesting that when perfect numbers are multiplied by two they produce superperfect or superabundant numbers, and when they are divided by 2 they produce deficient numbers.
The Pythagoreans spoke of numbers like this:

- One is God
- There are two substances
- Three unites the moniad And the dyad in saeba has the nature of both
- Tetrad - a form of perfection, in fact an expression of the emptiness of everything
- Decade - as the sum of everything includes the entire Cosmos

Pythagorean geometry

Given that in ancient times, until Pythagoras, particular attention was paid to geometry, because in ancient times the basis of everything was logic and geometry, it was Pythagoras who made a huge - priceless contribution to geometry. Everyone knows the Pythagorean theoreme geometric figures, but it is not bad to mention them:
The Pythagorean theoreme reads:
The sum of the areas of the square constructed over the legs as sides is equal to the area of the square constructed over the hypotenuse as the side.or more simply:

The square over the hypotenuse is equal to the sum of the squares over both legs

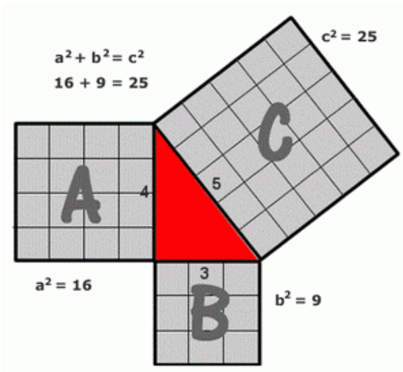


Figure 1. Pythagoras theoreme

Pythagorean Spheres and cosmic harmony

Pythagoras is also a pioneer in calculating the sphere. And the beginnings of creating music are connected to the Pythagorean sphere and harmony.

What is the difference between a circle and a circle? A circle consists of all points that are equidistant from one fixed point, the center of the circle. Therefore, a circle is only a circular line, while a circle consists of both the circle and all the points of the internal area bounded by the given circle. It is similar with the concepts of sphere and ball.

A sphere is the set of all points of space equidistant from one fixed point, the center of the sphere.

The radius of the sphere r is the distance of any point on the sphere from the center of the sphere.

A ball is a round body bounded by a sphere.

A ball is created by rotating a circle around any of its diameters.

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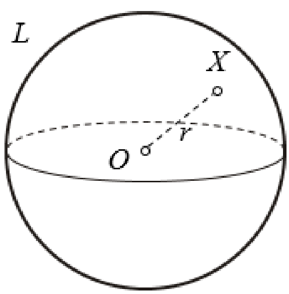

Figure 2. Pythagoras sphere

The intersection of a plane and a ball can be:

1) the empty set $\alpha \cap L = \emptyset$

2) point $\gamma \cap L = \{T\}$
3) circle $\beta \cap L = K$

Archimedes

Archimedes was an ancient mathematician, philosopher and inventor, who wrote very important works on geometry, arithmetic and mechanics.
He was born around 287 BC in Syracuse, on the east coast of Sicily (Italy). he was related to the ruler of Syracuse, Hieron. As a young man, Archimedes went to Alexandria, which was already the largest scientific center in the world. It is assumed that he studied under Euclid, whose book "Elements" he did not part with throughout his life. During his relatively short stay in Alexandria, he became friends with Conon from the island of Samos and Eratosthenes from Cyrene, with whom he later corresponded intensively. He valued them as mathematician, although Eratosthenes was not sympathetic to him, because of the humility and mediocrity he showed towards the powerful in Alexandria. He regularly informed them about his discoveries, and after Conon's death he corresponded with his student Dositheus.
Archimedes, like no one before, laid the foundations of mechanics, hydraulics, mathematical methods, geometry, hydrostatics and many other scientific disciplines.
Archimedes opened up new areas to science with a whole series of his discoveries. He established the ratio of the circumference to the diameter of a circle and calculated the constant π, placing it between 3 1/7 and 3 10/71 (π = 3.1408 to 3.1429). The explanation and calculation is given in the document "Circle measurement". Also, he determined the surface area and volume of the ball and the roller.
He made significant contributions in mechanics and astronomy. He discovered the law of leverage, was the first to exactly prove the laws of balance, clearly understood the concept of specific weight, and established the principles of hydrostatics in the book "O floating bodies". He became famous for his brilliant inventions in mechanics, war tools and devices for defense against the Romans.
A device that is still used today in certain parts of the world, Archimedes' screw, is used for irrigation or moving liquids, usually water, from one place to another.
Archimedes also made astronomical observations to determine the exact length of the year, and found it to be 365 1/4 days.
When he finished his education in Alexandria and returned to his homeland, he extended his ties with Alexandrian scientists through scientific correspondence. From a Jerusalem palimpsest in 1907, a book on methods was extracted, in which Archimedes appears as the predecessor of integral calculus.
Although many scientists, Archimedes' contemporaries, were engaged in science in the abstract sense, he preferred the practical application of knowledge. His inventions were used primarily for war purposes, such as catapults, but also in everyday life, e.g. Archimedes screw.
"Archimedes' heat rays" is one of his most interesting inventions that found wide application in the army of Syracuse. Archimedes found out about the focal point of concave mirrors, more precisely polished metal, which was then used for the same

purpose. The principle is based on the fact that by placing two mirrors, four-sided and six-sided, from which sunlight is reflected, all the heat is concentrated in one point. Thanks to this, enemy ships could be burned at a distance of fifty meters.

Archimedes' law states that any body immersed in a liquid acts on a thrust force equal to the weight of the liquid displaced by the body. In other words, a body immersed in a liquid becomes lighter by as much as the weight of the displaced liquid. This is the basic law of hydrostatics (and aerostatics). This law is general and applies to all fluids and gases, but it was first discovered with liquids.

This principle is the reason why boats float and air balloons fly. If the thrust force is equal to the weight of the body, the body is at rest.

The most famous anecdote about Archimedes is about how he came up with the method of determining the volume of irregularly shaped objects. According to the sources of Marcus Vitruvius, King Hieron II wanted to check whether the testamentary crown for the temple was made of pure gold, or whether the goldsmith had cheated him by using silver, which is cheaper. Archimedes had to solve the problem without damaging the crown, that is, he could not melt it, form a regular shape and then calculate its density. As he entered the tub to bathe, he noticed that the water level in the tub rose in direct proportion to the volume of his body, and he realized that this effect could be used to calculate the volume of the crown. Since water is an incompressible fluid, it is very suitable for use in this experiment because the submerged crown will replace an equal volume of water with its own volume. When dividing the mass of the crown by the volume of water that rose or spilled from the container, the density of the crown is obtained. If the obtained density value is lower than the density of gold, it means that the goldsmith used cheaper gold of lower quality or added other metals of lower density. Archimedes, coming to this conclusion, ran out of the tub, went out into the street completely naked, forgetting to get dressed, and shouted "Eureka!" (Greek: εὕρηκα, heúrēka! translated I discovered! I found!). The experiment was successfully carried out, showing that the king's suspicions were well-founded and that silver was also used in the making of the crown.

Archimedes sought the application of a principle from hydrostatics, known as Archimedes' law, which describes submerged, floating, and floating bodies. This law states (as already stated in the text above) that any body immersed in a liquid acts on a thrust force equal to the weight of the liquid displaced by the body. Based on this, it is possible to compare the density of a gold crown with pure gold if water is poured into two containers, a scale is placed and both objects are immersed in water. If there is a difference in the density of these two objects, the water level in both containers would not touch the same division on both scales. Galileo Galilei thought it very likely that this method was also used by Archimedes, since, in addition to being very precise, it was found in Archimedes' personal notes. In a text called the Mappae clavicula, which dates back to the 12th century, there are instructions on how to measure water in order to determine the percentage of silver used and thereby solve the problem. The 4th or 5th century Latin poem Carmen de ponderibus et mensuris describes how to use hydrostatic balance to solve the crown problem, and attributes the procedure to Archimedes.

Archimedes dealt with ordinary, practical problems, which were applied in many places, from fields to mines, unlike some of his colleagues. He gained the greatest fame with his discussions on rounded geometric bodies, whose surface and volume he calculated using a complex method close to today's infinitesimal calculus. He also found the laws of leverage, laid the foundations of hydrostatics and determined the approximate value of the number pi (3.14). In addition, he invented the Archimedes screw for raising large amounts of water to a higher level. He discovered Archimedes' law, which enabled him to discover the uses of base metals in King Hieron's crown.

What he is best known for are "Archimedes' machines".

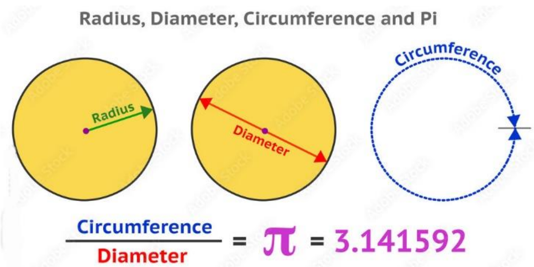

Figure 3. Arvhimedes number P

He was killed by the Romans during the siege of Syracuse in the Second Punic War.

An important result that Archimedes first arrived at is the number π, which represents the ratio of the circumference to the diameter of a circle:

One of the world's ancient wonders of technology is the Antikythera device. Antikythera is considered the most sophisticated example of the technology of the ancient Greeks. The internal mechanism is made of bronze wheels, and there is a large dial on the front. Instead of showing the time, it showed the movements of the Sun, the Moon and other celestial bodies known at the time.

Figure 3. Arvhimedes Antikithera

Abu Abdullah Muhammad ibn Musa al Khwarizmi

Abu Abdullah (or Abu Jafar) Muhammad ibn Musa al-Khwarizmi (c. 783-c. 850) - one of the greatest scientists of the IX century, the"father of algebra", mathematician, astronomer, geographer and politician. It was he who began to use the Indian numerals, which today are called Arabic. Al-Khwarizmi introduced Europe to Arabic numerals.Khwarizmi led the state library during the reign of Caliph Mamun and was one of the active members of the House of WisdomAl Khwarizmi introduced modern numerical notation. Little is known about El Khwariymi's life; he was a member of the Baghdad Academy of Sciences and wrote about mathematics, astronomy and geography.Khwarizmi also managed to explain the ancient Indian heritage and ancient scientific results in the field of mathematics.During his primary education, he learned in detail the main guidelines of Iranian pre-Islamic mathematics and astronomy. As he continued his research in that field, he grew into one of the most celebrated representatives of the university in Jundishapur.While working on certain scientific projects within the large university in Jundishapur, he got to know in detail the ancient Indian and ancient Persian astronomical traditions and scientific literature. Later it turned out that these researches were of great importance because he managed to translate some Indian and Pahlavi books into Arabic much more simply and precisely. However, we should not forget that his fame is not the result of his translations.Many consider him the father of algebra. In addition, the term algorithm, which originally described the method of calculating with decimal numbers and was formulated by Khwarizmi, was taken from the Latin transcription of his name.According to historians of mathematics, Muslims became familiar with the ancient Indian number system through the famous work al-Jam wa at-tafrik fi hisab el Hind [Addition and Subtraction in Indian Arithmetic] by Muhammad ibn Musa Khwarizmi. We can claim with great certainty that this book is the oldest work written on arithmetic in the Islamic world. However, although its original Arabic copy has not yet been found, its Latin translations are available to us. In that book, Khwarizmi brilliantly clarified the ancient Indian number base and transferred it to the Islamic world.Khwarizmi's fame comes mostly from his eminent masterpiece al-Jabr [Algebra], because of which this mathematical discipline founded by Khwarimi gets that name in later literature. This name is still used in the West today to refer to this mathematical discipline. Therefore, the name of this science, which in the modern French language is used in the context of the word algebra, and in English algebra, draws its lexical roots from the Arabic name al-jabr, mentioned in the title of Khwarizmi's famous book However, he gives a general method (Al Khwarizmi's solution) for finding two roots of a quadratic equation. Al-Khwārizmī's method of solving linear and quadratic equations worked by first reducing the equation to one of six standard forms (where b and c are positive integers):

- squares equal roots ($ax^2 = bx$)
- squares equal number ($ax^2 = c$)
- roots equal number ($bx = c$)

- squares and roots equal number ($ax^2 + bx = c$)
- squares and number equal roots ($ax^2 + c = bx$)
- roots and number equal squares ($bx + c = ax^2$).

As part of 12th century wave of Arabic science flowing into Europe via translations, these texts proved to be revolutionary in Europe. Al-Khwarizmi's Latinized name, *Algorismus*, turned into the name of method used for computations, and survives in the term "algorithm". It gradually replaced the previous abacus-based methods used in Europe. Four Latin texts providing adaptions of Al-Khwarizmi's methods have survived, even though none of them is believed to be a literal translation:

- *Dixit Algorizmi* (published in 1857 under the title *Algoritmi de Numero Indorum*
- *Liber Alchoarismi de Practica Arismetice*
- *Liber Ysagogarum Alchorismi*
- *Liber Pulveris.*

Dixit Algorizmi ('Thus spake Al-Khwarizmi') is the starting phrase of a manuscript in the University of Cambridge library, which is generally referred to by its 1857 title *Algoritmi de Numero Indorum*. It is attributed to the Adelard of Bath, who had translated the astronomical tables in 1126. It is perhaps the closest to Al-Khwarizmi's own writings.

Al-Khwarizmi's work on arithmetic was responsible for introducing the Arabic numerals, based on the Hindu–Arabic numeral system developed in Indian mathematics, to the Western world. The term "algorithm" is derived from the algorism, the technique of performing arithmetic with Hindu-Arabic numerals developed by al-Khwārizmī. Both "algorithm" and "algorism" are derived from the Latinized forms of al-Khwārizmī's name, *Algoritmi* and *Algorismi*, respectively.

Josip Ruđer Bošković

Boscovich was born on 18 May 1711 in Dubrovnik, Republic of Ragusa, to Paola Bettera (1674–1777), daughter of a local nobleman of Italian origin, and Nikola Bošković, a Ragusan merchant. He was the seventh child of the family and the second youngest. His father was born in the village of Orahov Do near Ravno, at the time part of the Ottoman Empire (now Bosnia and Herzegovina)

Notwithstanding the arduous duties of his professorship, he found time for investigation in various fields of physical science, and he published a very large number of dissertations, some of them of considerable length. Among the subjects were the transit of Mercury, the Aurora Borealis, the figure of the Earth, the observation of the fixed stars, the inequalities in terrestrial gravitation, the application of mathematics to the theory of the telescope, the limits of certainty in astronomical observations, the solid of greatest attraction, the cycloid, the logistic curve, the theory of comets, the tides, the law of continuity, the double refraction micrometer, and various problems of spherical trigonometry

In 1745, Bošković published *De Viribus Vivis* in which he tried to find a middle way between Isaac Newton's gravitational theory and Gottfried Leibniz's metaphysical theory of monad-points. He developed a concept of "impenetrability" as a property of hard bodies which explained their behaviour in terms of force rather than matter. Stripping atoms of their matter, impenetrability is disassociated from hardness and then put in an arbitrary relationship to elasticity. Impenetrability has a Cartesian sense that more than one point cannot occupy the same location at once.

Bošković visited his hometown only once, in 1747, never to return. He agreed to take part in the Portuguese expedition for the survey of Brazil and the arc measurement of a degree of latitude (meridian arc), but was persuaded by the Pope to stay in Italy and to undertake a similar task there with Christopher Maire, an English Jesuit who measured an arc of two degrees between Rome and Rimini. The operation began at the end of 1750, and was completed in about two years. An account was published in 1755, under the name *De Litteraria expeditione per pontificiam ditionem ad dimetiendos duos meridiani gradus a PP. Maire et Boscovicli.* The value of this work was increased by a carefully prepared map of the States of the Church. A French translation appeared in 1770 which incorporated, as an appendix, some material first published in 1760 outlining an objective procedure for determining suitable values for the parameters of the fitted model from a greater number of observations. An unconstrained variant of this fitting procedure is now known as the L1-norm or Least absolute deviations procedure and serves as a robust alternative to the familiar L2-norm or Least Squares procedure. A dispute arose between Francis the Grand Duke of Tuscany and the Republic of Lucca with respect to the drainage of a lake. As an agent of Lucca, Bošković was sent, in 1757, to Vienna and succeeded in bringing about a satisfactory arrangement in the matter. Here he met Karl Scherffer who became an influential promoter of the ideas of Bošković in Austria.

The first page of figures from *Theoria Philosophiæ Naturalis* from 1763. Figure 1 is the force curve which received so much attention from later natural philosophers such as Joseph Priestley, Humphry Davy, and Michael Faraday. The ordinate is force, with positive values being repulsive, and the abscissa is radial distance. Newton's gravitational attractive force is clearly seen at the far right of figure 1. In Vienna in 1758, he published the first edition of his famous work, *Philosophiæ naturalis theoria redacta ad unicam legem virium in natura existentium* (*Theory of Natural philosophy derived to the single Law of forces which exist in Nature*), containing his atomic theory and his theory of forces.In 1764, he was called to serve as the chair of mathematics at the University of Pavia, and for six years he held this post with the directorship of the observatory of Brera in Milan, That is where Charles Burney met him; since Burney's Italian was not very good at that time, Boscovich obliged him speaking French.

He was invited by the Royal Society of London to undertake an expedition to California to observe the transit of Venus in 1769 again, but this was prevented by the recent decree of the Spanish government expelling Jesuits from its dominions. Bošković had many enemies and he was driven to frequent changes of residence. About 1777, he returned to Milan, where he continued to teach and direct the Brera observatory.

Deprived of his post by the intrigues of his associates, he was about to retire to Dubrovnik when in 1773, the news of the suppression of his order in Italy reached him. Uncertainty led him to accept an invitation from the King of France to come to

Paris where he was appointed director of optics for the navy, with a pension of 8,000 *livres* and a position was created for him.
He naturalised in France and stayed for ten years, but his position became irksome, and at length intolerable. He, however, continued to work in the pursuit of scientific knowledge and published many remarkable works. Among them was an elegant solution to the problem of determining the orbit of a comet from three observations, and works on micrometer and achromatic telescopes. Bošković was also consulted on civil works concerning ports and rivers: Ivica Martinović has shown the extent to which Bošković applied himself to such works, and lists 13 major works:

- assessment of damage to the timber jetties in the Fiumicino, the navigable branch of the River Tiber (1751);
- the Ozzeri project, spurred by a bitter controversy on the floods in the border area between Lucca and Tuscany (1756);
- plan for the drainage of the Pontine Marshes, including the evaluation of an earlier project by Manfredi and Bertaglia (1764);
- analysis of the causes of damage to the port of Rimini, accompanied by reparation measures (1764);
- assessment of the levees along the River Po (1764);
- scientific letter on the principles of hydrodynamics in Lecchi's Idrostatica (1765);
- report on the floods in the Perugia area (1766);
- official report on the damage to the port of Savona, the underlying causes and the possibilities of repair (1771);
- expert opinion referring to the River Tidone in the Piacenza area (1771);
- proposal for the renovation of the fountains in Perugia (1772);
- expert opinion on the mouth of the River Adige as compared with the proposals by Antonio Lorgna and Simun Stratik for the improvement of the river bed (1773);
- instructions for the establishment of a team responsible for the drainage of the Pontine Marshes (1774);
- comments on Ximenes's project for the Nuovo Ozzeri drainage channel in Lucca (1781).

In the field of astronomy, Rudjer gave 115 years before Einstein the basics of relativity theory and established light as a constant (c). Rudjer's model of the atom introduced the law of forces, responsible for small inter-electron distances, and for attraction at long distances. This was later further developed by Michael Faraday. Rudjer positioned atom to the central point around which are fields of attractive-repulsive forces (Boskovic's field).He gave experiments of direct and alternating current in his works that are stored in the Vatican 120 years before Nikola Tesla.

Conclusions

This paper is a review of the four most important scientists (in my opinion), who laid the foundations of new sciences. Nowadays, it is a popular opinion that various scientists have built the sciences we use, but this work shows that this is not true. This paper is in no way a criticism or any malicious attempt to challenge any scientist. It

only points to scientists who really founded new sciences such as: geometry, mechanics, hydraulics, astrophysics, statics, geodesy, modern mathematics, etc.
The idea is to continue researching the role and influence of these four scientists on the development of today's world and to interpret all their inventions. These big four have made such advances that we have not yet been able to fully see and understand. The fact is that without the big four, today's science would not exist.

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