UNRAVELING THE MYSTERY OF THE ANCIENT OLBIA GEARWHEEL

9 January, 2016 - by April Holloway, London

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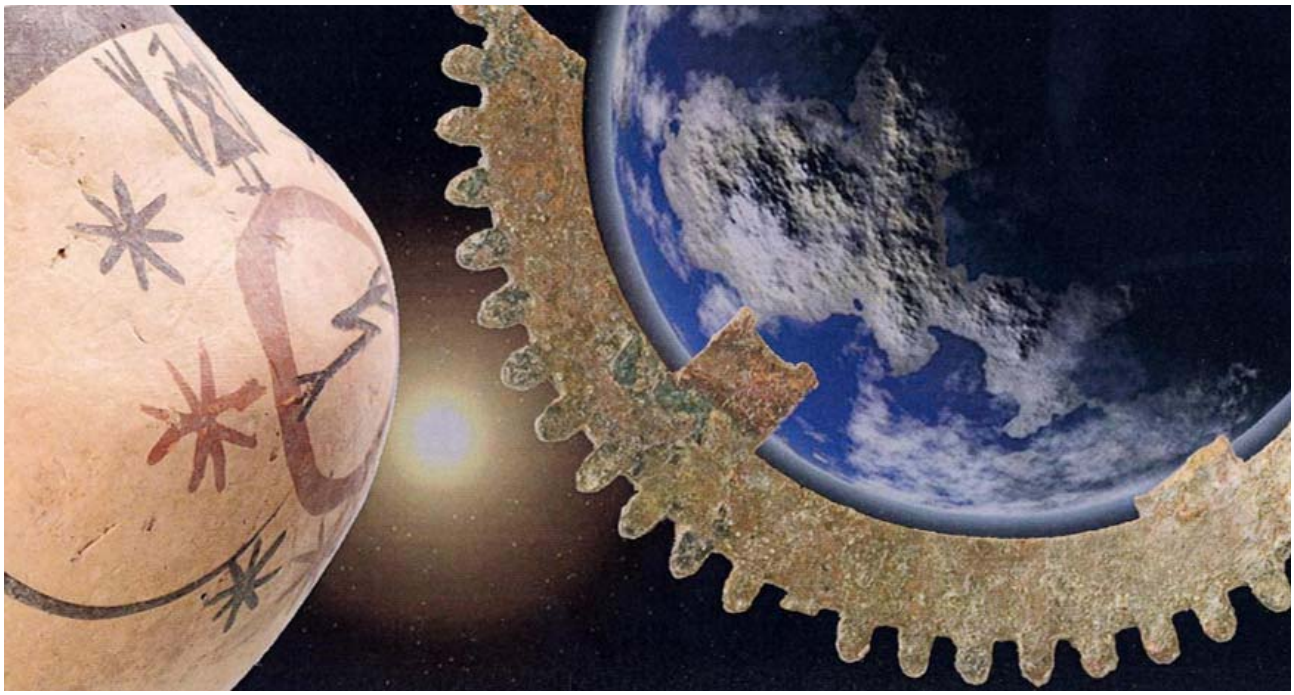

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Unraveling the Mystery of the Ancient Olbia Gearwheel

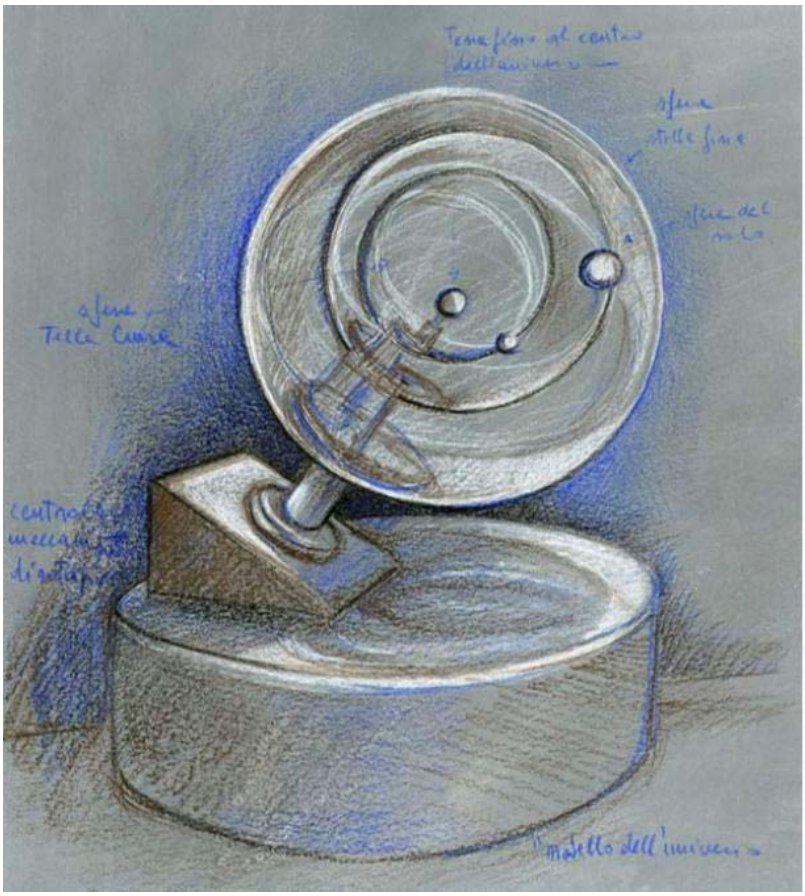
The restoration of the gearwheel found in Olbia (Sardinia, Italy) in 2006 by the Superintendence for Archaeological Heritage, dated between the mid-2nd century and the end of the 3rd century BC, has revealed a very important surprise: the teeth have a special curving which make them extraordinarily similar to the mathematically perfect profile used in modern gears. Moreover, the

unusual composition of the alloy (brass) was completely unexpected. As it turns out, the gear is very scientifically advanced despite being constructed before all other known mechanisms to date. Considering the perfect correlation between the scientific evidence and historical, literary and archaeological studies, it does not seem rash to conclude that the fragment from Olbia was an integral part of the Archimedes Planetarium (Orrery).

The Archimedes Planetarium

The Archimedes Planetarium was one of the most admired technical achievements in antiquity. The best information on this apparatus is given by Cicero, who writes that in the year 212 BC, when Syracuse was sacked by Roman troops, the consul Marcus Claudius Marcellus brought an apparatus constructed by Archimedes to Rome that reproduced the vault of the sky on a sphere, and another that predicted the apparent motions of the Sun, Moon and planets, thus corresponding to a modern planetarium. Cicero, referring to the impressions of Gaius Sulpicius Gallus, who had been able to observe the extraordinary object in person, points out that the genius Archimedes was able to generate the motions of planets, each so different from the next, with a single rotation. Archimedes had described the construction of the Planetarium in the work *On Sphere-Making*. News of the work, now considered lost, was reported by Pappus of Alexandria.

- **Archimedes: An Ancient Greek Genius Ahead of His Time**
- **Cicero and the Forgotten Tomb of Archimedes**



A sketch proposing what Archimedes' Planetarium looked like (museo galileo)

Ancient knowledge of the cosmos

The discovery of the Antikythera Planetarium in 1902, a gear device that dates back to the first half of the 1st century BC also shows how the ancient people developed mechanisms designed to represent the motion of the stars, which in turn has rekindled interest of the Archimedes Planetarium.

- **The Antikythera Shipwreck – The Titanic of the Ancient World and its Sunken Historic Treasure**
- **New analysis of Antikythera Mechanism reveals clues to one of history's greatest puzzles**

The Antikythera mechanism / planetarium discovered in 1902 (public domain)

With the discovery in 2006 in Olbia of the fragment of an ancient gear, scientifically and technically more advanced than the gear of Antikythera, and after deep, careful and thorough studies considered part of a planetarium designed by Archimedes, it has shed a new and unexpected light on the magnitude of scientific thought of the genius of Syracuse. The scientific and

mathematical studies of the find have shown that many inventions that we consider modern had in fact already been developed and designed by Archimedes over two thousand years before.
The importance of the find, also, is in the fact that to date only a few written works by Archimedes have ever been retrieved (Codices *A*, *B* and *C*) through transcriptions and translations in Greek, Arabic and Latin. Codex *C* is the oldest Archimedes Codex, the only one still written in Greek on a parchment paper with laid lines in 975, and which became Palimpsest in Jerusalem in 1229, and it is still the subject of studies in the United States. Of Archimedes' machines, however, it was thought nothing had survived. The find, although small, is not a simple piece of crockery, but instead a great testimony and thus a new, unique and unexpected contribution to the scientific knowledge of the great Archimedes.

The Archimedes Palimpsest revealed works by Archimedes thought to have been lost (public domain)

The knowledge of epicyclic motion, also known as planetary motion, necessary for the design of the planetary gear in the Planetarium of Antikythera and in the tooth profile of the gear of Archimedes, allows us to assume that some ancient Greek scientists knew the planetary motion of celestial bodies and had achieved the same results later attributed to modern scientists 2000 years later. I

assume that the planetary gear could have been used, given the particular kinematic similarity, as a mathematical model for the calculation of planetary motion in the heavens.

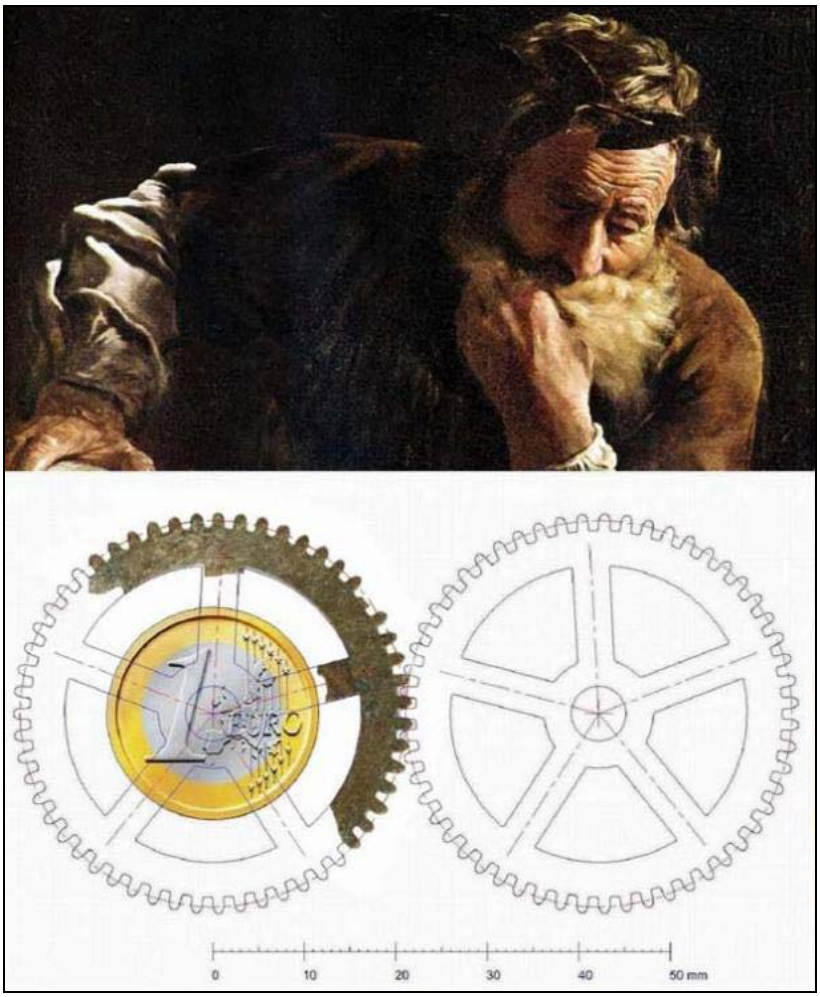
The discovery of the Olbia gear

In July 2006, during an emergency excavation in the municipal market square in the city of Olbia, a fragment of a toothed wheel of 43 mm (1.6929 inches) was found. The Superintendence for the Archaeological Heritage of Sardinia, who directed the excavation, gave due importance to a seemingly insignificant and oxidized metal fragment. The find appeared similar to the gears of the Antikythera Mechanism, discovered in Greece, conserved in the National Archaeological Museum of Athens, and much talked about in that period because further modern tomographic analysis was being carried out in Athens. The correct dating of the find of Olbia in the archaeological record of the layer, sealed by the already ancient upper one, was determined by the Superintendence for Archaeological Heritage. The find, and the whole layer of the excavation, was dated from the late 3rd to half of the 2nd century BC, for the presence of other easily datable finds, all pertaining to the same period.
The day after the discovery the Superintendent invited me to scientifically study the mechanical artifact by virtue of my forty years of expertise and experience in the design and construction of the modern gears, and especially having long studied and also published works on other ancient gear mechanisms, including Antikythera.

Studying the gear of Olbia

The gear teeth of Olbia, at the time of discovery, seemed to have a triangular profile, such as the Antikythera calculator, which dates back to the 1st century BC, and other similar mechanisms made in later centuries, whose meshing, however, is very coarse.
After restoration, however, a very important surprise emerged: the teeth were not triangular in shape but the flanks had a special curvature. When I examined the high-resolution photographs of the find, with the teeth cleaned of oxide, I saw the extraordinary similitude with curved teeth of modern gears, whose "conjugate profile" is the result of accurate and deep mathematical studies formulated by eminent scientists in the 18th century. Another surprise was the results from of the instrumental analysis by SEM, performed by the Superintendence on the find, which showed that the alloy was not bronze, as would be expected because it was very common in antiquity, but brass, an alloy of copper and zinc much more rare and precious than bronze due to difficulties in manufacturing it, but more appropriate for the construction of the gears thanks to better mechanical and technological properties. The gear is therefore more scientifically advanced, that is in terms of metallurgy and mathematics, even though it was made before all the other mechanisms we have seen so far. This means that those who had created the profile had mathematical knowledge and were also learned in metal technology, at least 20 centuries ahead of their time. This unique profile makes the mathematical meshing technically perfect and this can only be the result of a brilliant mind. The author’s first thought concerning the gear went to Archimedes of Syracuse, both because he was the

most esteemed mathematician of his time, and also because we know from classical literary sources (Cicero, Ovid, Lactantius, Claudio) that he had built a Planetarium, presumably with gears. Given the perfect correlation between the evidence and the historical, literary and archaeological data, and which I will discuss later, it seems safe to conclude that the fragment was an integral part of Olbia in the Archimedes Planetarium.



Top: Archimedes Thoughtful by Fetti, 1620 (public domain). Bottom: illustration of the Olbia gear (image supplied by author)

As can be noted from the many published articles, the extraordinary findings seen in the mathematical study of the profile of the teeth were immediately released in print, online and in other national and international scientific conferences. The extraordinary and certain incontrovertible scientific evidence was that the construction of the piece was obviously scientifically superior to all other gear mechanisms that we are aware of, made in the following twenty centuries. However, despite the fact that the scientific and engineering study of the find conducted by the writer took several years of intense and demanding work, the decision on its attribution was not taken immediately rashly, superficially or even lightly. It was not easy because I was aware of the enormous responsibility that would be derived from the concluding remarks. Precisely because of the unexpected findings that, as I said, have emerged from the first comparative mathematical analysis, further confirmation and insight was needed in order to come to

the decision of the attribution to the Planetarium of Archimedes at the end of a long, thoughtful and suffered path of study and research.
The study's findings were published in a few essential lines in the proceedings of the XVIII International Congress of studies on "Roman Africa" held in Olbia on 11 to 14 December 2008. Due to the vast amount of work compared to the space available in the publication referred to above, it was not possible to report the whole study and the scientific and engineering aspects were removed. After much thought I felt a special publication was needed in which to present a complete study of the find. This is because I felt a duty to universal culture and the history of science to give a complete view of the gear of the study, especially the scientific and engineering aspects that were fundamental and decisive for the attribution of the gear to the Archimedes Planetarium. In my book *The Recovered Archimedes Planetarium*, all the reasons and scientific texts are listed which led me to attribute the fragment of the gear found in Olbia at the Planetarium of Archimedes.

Featured image: The Olbia gear. Image supplied by author.
This article has been extracted from *The Recovered Archimedes Planetarium* and has been republished with permission. For more information, please visit:
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The Author

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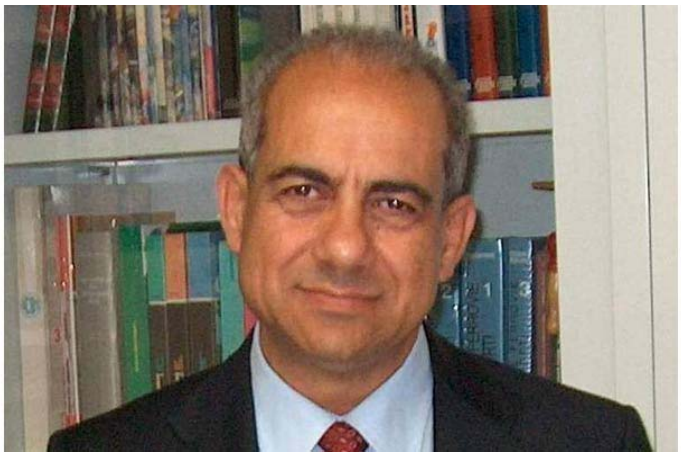


8 February, 2013 - 12:02 ancient-origins

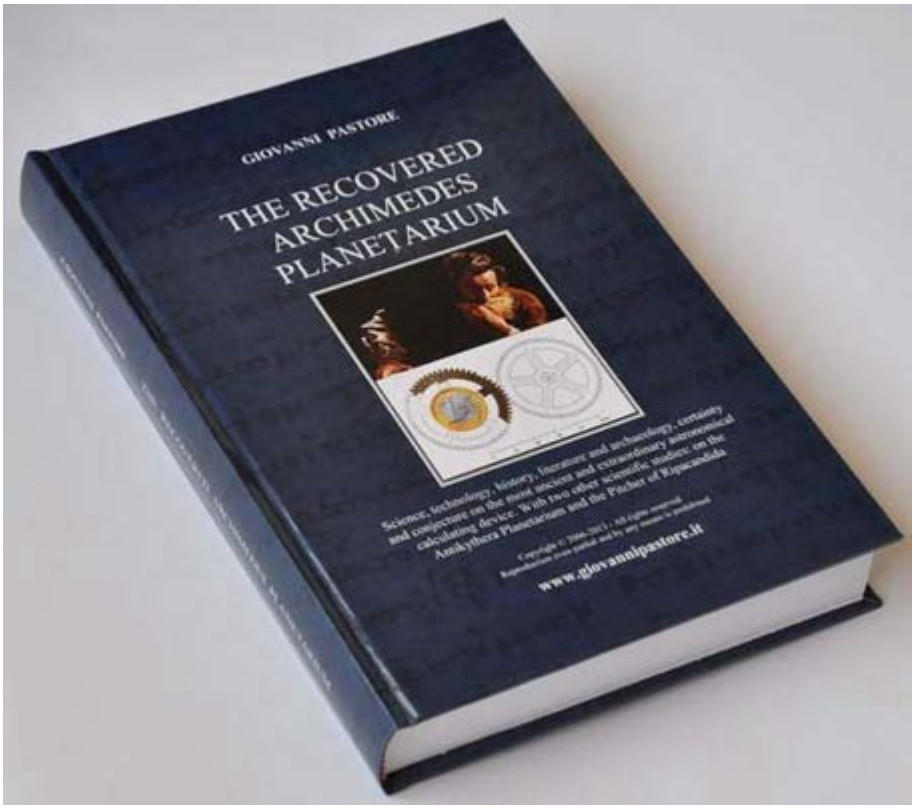
Prof. Giovanni Pastore

Professor **Giovanni Pastore** (1954, Rotondella - Basilicata, Italy), received his degree in mechanical engineering at Turin Polytechnic University in 1978. Even before graduating he was offered a contract at Fiat Mirafiori in Turin, where for the following five years he worked at the automotive design office, dealing with structural calculations.

He was a reserve officer with the Army Corps of Engineers at the plant of ex-combat vehicles STAVECO at Nola (Naples, Italy), appointed with the task of the revision and testing of tanks (Leopard and M113). Some years later he was recalled to duty, at the same plant, for technical updates and degree advancements.
He has lived and worked in Policoro (Basilicata, Italy) since 1982, where he works as a freelance engineer and Professor of Mechanical Engineering at the Faculty of Mechanical Engineering at several Italian universities.
He has published numerous scientific articles and books: in Italian, *Gli infortuni domestici. Come prevenirli* (ISBN 9788890471506), *Antikythera e i regoli calcolatori* (ISBN 9788890471513), *Il Planetario di Archimede ritrovato* (ISBN 9788890471520), *Pitagora nel mondo contemporaneo. Influenze della filosofia scientifica pitagorica nel mondo moderno e contemporaneo* (ISBN 9788890471537) and in english *The Recovered Archimedes Planetarium* (ISBN 9788890471544).

Website: http://www.giovannipastore.it/index_english.htm

The Recovered Archimedes Planetarium



Science, technology, history, literature and archaeology, certainty and conjecture on the most ancient and extraordinary astronomical calculating device. With two other scientific studies: on the Antikythera Planetarium and the Pitcher of Ripacandida.

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unusual composition of the alloy (brass) was completely unexpected. As it turns out, the gear is very scientifically advanced despite being constructed before all other known mechanisms to date. Considering the perfect correlation between the scientific evidence and historical, literary and archaeological studies, it does not seem rash to conclude that the fragment from Olbia was an integral part of the Archimedes Planetarium (Orrery). In this book, you will find all the supporting evidence and the scientific tests which have led me to attribute the fragment of the cogwheel found in Olbia to the Archimedes Planetarium.

There are also two recent scientific studies presented in this work. In the second part of the book, a study is presented on the kinematic model of the Greek Antikythera Planetarium also used in the gear of Olbia which predates Copernicus' heliocentrism. The knowledge of epicyclic or planetary motion, necessary for the design of the epicyclic gearing in the Antikythera Planetarium as well as in the tooth profile of the Archimedes gear, lets us presume that some Hellenistic scientists were aware of how to calculate the planetary motion of celestial bodies. They could, therefore, have achieved the same results attained in the modern age, 2000 years later. The third part of the work presents the study of the 5th century BC Pitcher of Ripacandida in Basilicata (Italy) of Pythagorean derivation and the historical event of a great meteorite impact on the Earth is revealed, thus demonstrating that the extraordinarily modern physical laws graphically represented on the pitcher are in complete antithesis with the successive dogmatic physics of Aristotle.