National and Kapodistrian University of Athens
School of Science, Faculty of Physics

Department of Astrophysics, Astronomy and Mechanics
Panepistimiopolis, 15783 Zografou
Tel +30 6978792891
xmoussas@phys.uoa.gr

proposal for an

Exhibition of the Antikythera Mechanism and Greek Astronomy

Xenophon Moussas, University of Athens

National and Kapodistrian University of Athens
Physics Faculty
Department of Astrophysics, Astronomy and Mechanics
Panepistimiopolis, 15783 Zografou
Tel 6978792891
xmoussas@phys.uoa.gr

19/3/2024

Exhibition of the Antikythera Mechanism

It is proposed to have an exhibition for the Antikythera Mechanism for the young people and the general public in your institution. The exhibition is an excellent attractor of young to science, technology and philosophy. We have made very many good exhibitions on the Antikythera Mechanism, the oldest computer and scientific instrument in Greece and other countries, mainly in Museums and Universities and schools with great success.

Image 1 a model/ replica Mechanism of Antikythera

Image 2 cartoon published in newspapers that shows the pervasiveness of the Mechanism of Antikythera to the general public.

The Antikythera mechanism is an ancient machine, a computer and is a wonderful attractor of children in Philosophy, Science, Mathematics, Astronomy and Technology and it is used as such to attract young people to these disciplines.

Feasibility and added value for the local community

Feasibility and added value for the people and especially for the young is manifold. The exhibition highlights in the best possible way how humans have started civilization and especially science based on mathematics, and how the thought to create a mechanical cosmos using the laws of nature, written in mathematics and programmed with gears.

Briefly:

1) **The mechanism shows that humans understood causality,**
2) **That there are laws of physics,**
3) **That the laws of physics can only be expressed with appropriate mathematics (Pythagoras, Plato)**
4) **That mathematics can be expressed with trains of turning gears that enable humans to create the first computer.**
5) **The mechanism and the exhibition shows that the Greeks develop high technology in antiquity, in contrast to what is generally believed**

Image 3 Our Exhibition (together with a Lego model) at the NASA Kennedy Space Center, Florida.

6) **The Mechanism of Antikythera is an excellent educational device to teach modeling og natural phenomena**
7) **The Mechanism of Antikythera is the best educational instrument to teach Greek Philosophy and especially the Pythagorean one.**
8) **It teaches Greek history.**
9) **It inspires young people shwing that humans can set difficult targets, that can achieve with appropriate careful plan and hard work.**

The Antikythera Mechanism is a unique ambassador of Greece and Greek civilization that visitor will probably remember forever.

Objective of the project

The objective of the project is to prepare an exhibition that will aquaint the people with some aspects of Greek civilization, especially this ancient astronomical instrument that is the oldest known computer and astronomical clock, a mechanical cosmos, a planetarium. The exhibition shows that the Greeks have developed technology not only for war but also for science and that the Greek automate we read in the litterature are real, that they existed and that there were several examples of them.

The young visitors of the exhibition will be inspired to study more classics, mathematics, physics and technology, including computing and informatics, engineering, astronomy, archaeology and philosophy.

Image 4 One of the fragments of the Mechanism that shows some parts of the user's manual of the instrument with the laws of physics used to predict the phases of the Moon and the eclipses. The study of the mechanism is a challenging puzzle that will inspire the young.

The exhibition

The exhibition presents the Antikythera Mechanism, which is the oldest computer, the oldest known complex astronomical instrument and probably, as I prove in my research, and astronomical clock and planetarium, the first mechanical Cosmos.

The mechanism is much more advanced than astronomical clocks that appeared in the rest of Europe since the 14th century, which are children of the mechanism. This ancient object, an artifact, that is now on display at the National Archaeological Museum in Athens.

Image 5 The mechanism in an exhibition in Cyprus

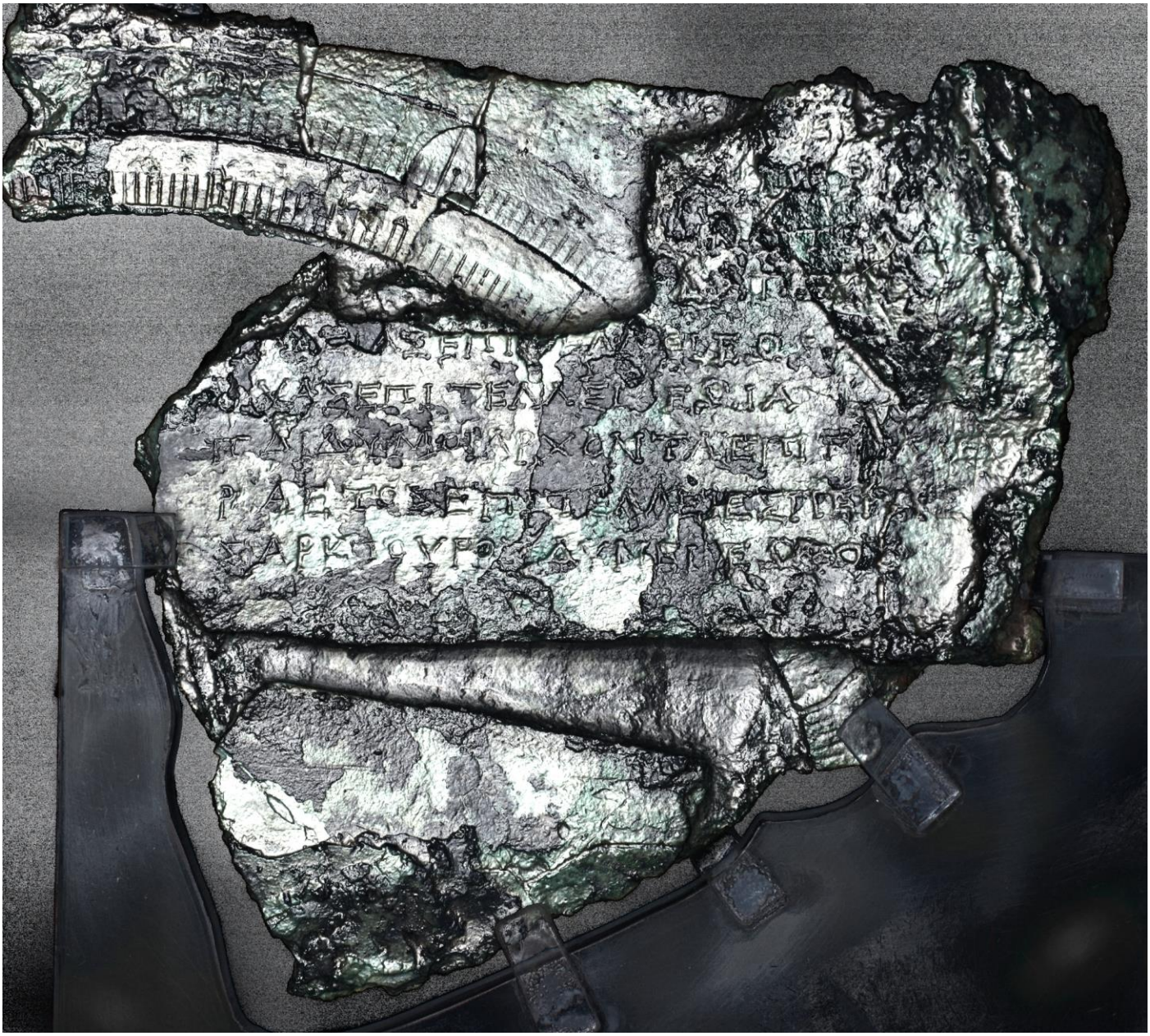

Image 6 One of the fragments of the Mechanism that shows some parts of two cyclical scales with the year and a map of the sky with the ecliptic and the zodiac. We see part of the user's manual of the instrument.

Image 7 Prof. George Smoot, Physics Nobel Prize in one exhibition of the Antikythera Mechanism

Image 8 the exhibition at UNESCO, Paris

Antikythera Mechanism is universally considered one of the most important archaeological artifacts. The mechanism is very important not only for Greece, but for Europe and all humanity. Our study provides robust evidence that the Greeks were developing high-level science and technology based on knowledge of the laws of physics, much higher than estimated or usually accepted so far by the global scientific community.

Antikythera Mechanism as an educational device and a great attractor of children to science, mathematics, technology and philosophy

The Antikythera Mechanism is currently used as an educational tool, as it attracts young people in technology, science, philosophy, archaeology, mathematics, astronomy, philosophy and so on. The study it as an educational device too and we have evolve it to a learning tool and we use it in Schools, Universities and in exhibitions around the world and Greece with an excellent results.

Depending upon the space and area available for the exhibition we present this unique object, the Antikythera Mechanism, and some aspects of the history of science and natural philosophy.

The exhibition, depending on the conditions includes:

1. a bronze model (replica) in natural size (32 x 12 x 20cm), and possibly other astronomical instruments, if there is enough space

2. 20 to 25 panels (usually sized 100 x 70 cm or 140 x 100 cm or any suitable one). The number and shape of the panels is always adapted to the space available.

3. Two interactive computer models, made by Professor Manos Roumeliotis and artist Mrs Amalia Porligkou on two computers

4. Brief film Mr Nikos Giannopoulos 4.5 minutes

5. a longer video with explanations with duration of 15 to 30 minutes.

6. many interactive three-dimensional photographs (in computers) that are the most important of the original photographs we have used in our study of the Antikythera Mechanism, which we created with the method of Mr. Tom Malzbender, HP.

7. Perhaps a longer film describing the Mechanism.

These can be in three to eight computers, two DVD players, a big screen or data projectors.

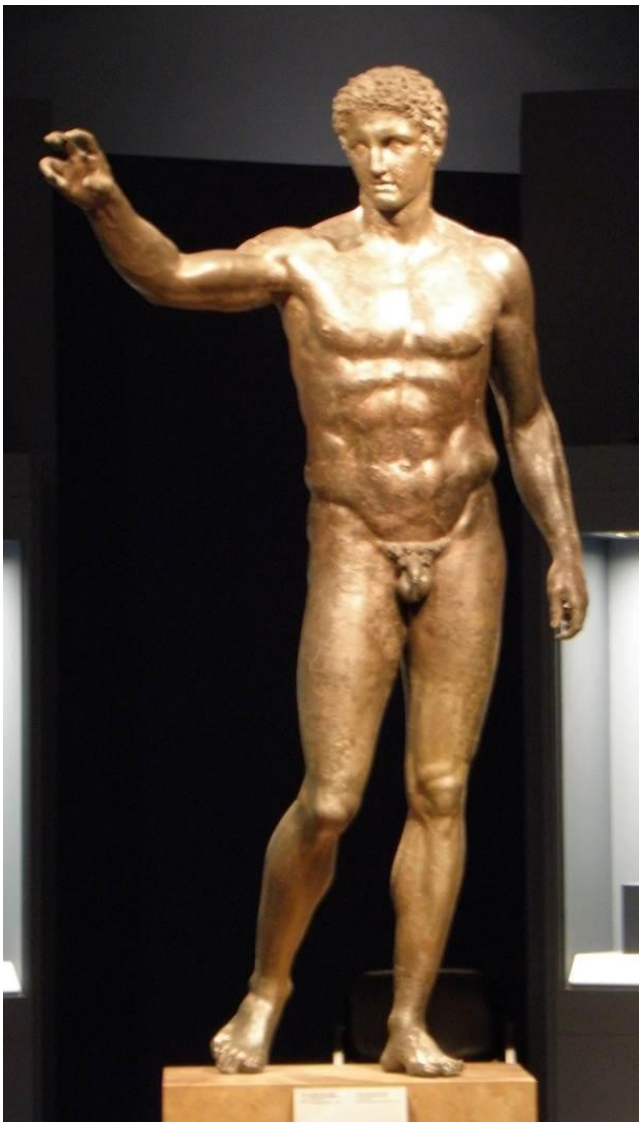

Image 9 the beautiful statue of the youth of Antikythera

Image 10 The gear of the Sun.

The Antikythera Mechanism is one of the most important finds of antiquity worldwide. It is the only ancient scientific instrument that survived the recycling of copper, a material that was more precious in antiquity that it is today.

The exhibition has been designed by Professor Xenophon Moussas of the University of Athens, one of the protagonists of the study of Antikythera Mechanism and a specialist in outreach and he is entirely responsible for it.

Xenophon Moussas

Astronomer, Professor of Space Physics (retired)

Image 10 Exhibition in an English school, Malvern, U.K.

Image 11 Exhibition in NASA, J. F. Kennedy Space Center, Florida

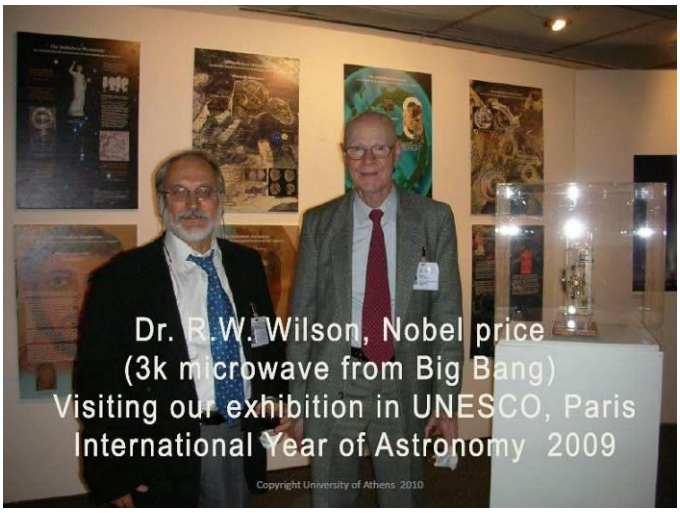

Image 12 Exhibition in UNESCO, Paris. The Nobel Prize winner Dr R W Wilson that discovered the Big bang visits our exhibition

Image 13 Exhibition at the Archaeological Museum of the University of Reading, U.K.

Image 14 Exhibition in Athens. The Nobel Prize winners George Smoot and David Gross

Image 15 Exhibition Moscow State Museum of Architecture

Image 16 Children in various exhibitions around the world (kindergarten, Ermione, Greece, Lefkas Island, Geece).

.

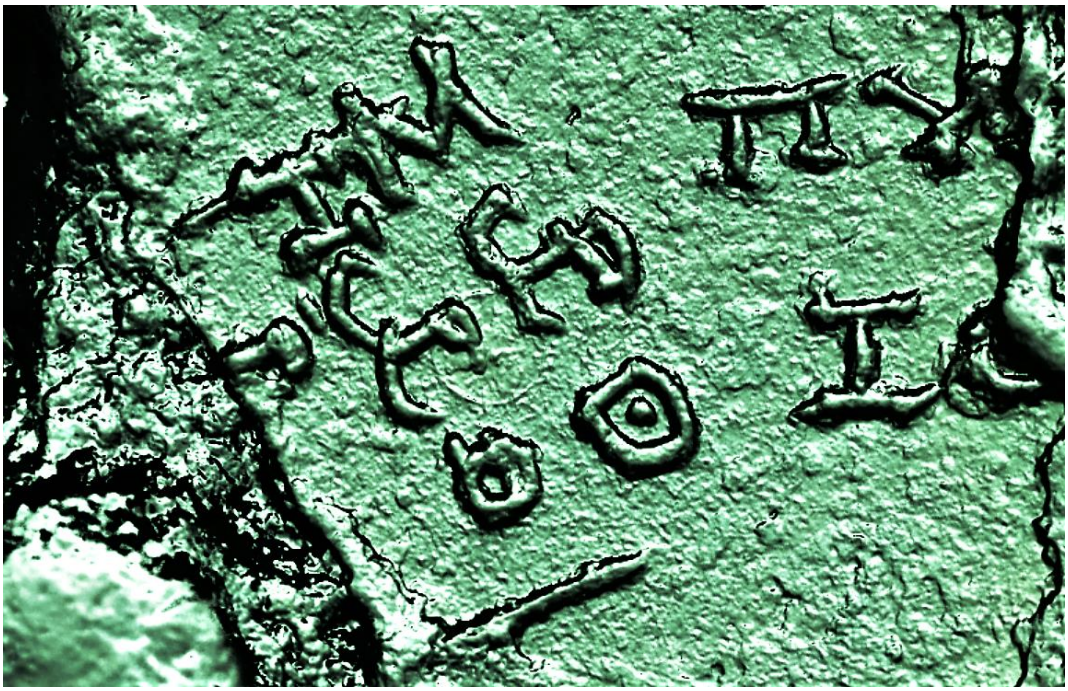

Image 17 Prediction of a solar and a lunar eclipse

Appendix

The Antikythera Mechanism is the oldest known computer, a clockwork Cosmos, a Planetarium, possibly an astronomical clock. It works with carefully designed gears that perform the appropriate mathematical operations to predict astronomical phenomena, the position of the Sun and the Moon in the sky, the age of the Moon, the beginning of the month, the solar and lunar eclipses.

The Antikythera Mechanism is the epitome of the Philosophy of the Pythagoreans, because to conceive the construction of such a machine, a computer, an automaton, which reproduces the movements of celestial bodies, is required to have a) the notion of determinism, b) that there the laws of nature, c) that the laws of nature are expressed with precision only with mathematics, d) that natural phenomena are understood and interpreted with the laws of physics, e) sometimes predicted by the laws of nature i.e. to construct such a mechanism you have to develop what is now called modelling in science, i.e. to conceive, develop and put in operation the doctrine of the Pythagorean philosophy that everything is described with mathematics.

The Antikythera Mechanism is made by Greek scientists, with appropriate knowledge of astronomy, mathematics, physics, engineering and metallurgy, with bronze gears that enable the constructor to perform specific calculations with gear trains and the user to find the position of celestial bodies in the sky. It shows the position of the Sun, the Moon (including its phase - age of the Moon), it predicts solar and lunar eclipses, it determines the years of the Greek Crown Games: the Olympics, the Naan, the Pythian, the Nemean, the Isthmian, festivities that enable the common person to keep the time and have a functional calendar for agricultural and pastoral purposes, fishing and hunting, that was and still is essential for all societies.

This wonderful scientific instrument is on display in the National Archaeological Museum in Athens together with other treasures, many of them found in the same shipwreck of the 1st century BCE.

The Antikythera Mechanism is one of the greatest discoveries of ancient artifacts globally. It is the oldest advanced scientific instrument and computer. It has been designed and constructed by Greek scientists, probably between 150 and 100 BC. Its dimensions are about 32x22x7cm. It was found near the small Greek island of Antikythera, at a depth of 45-60 meters Symian sponge divers, in a huge ancient shipwreck of the 1st century BC that was full of Greek treasures that were on their way from Greece to Rome.

The mechanism works with carefully designed gears made of bronze. These gears perform certain mathematical operations as they move around axles. The motion of gears moves pointers that show:

A) On side A of the instrument, two concentric scales with the zodiac and the solar year show:

1) the position of the Sun during the year in the sky, using a pointer with a golden little sphere.

2) the location of the moon during the month, using a little silver sphere that rotates around two axes and shows the phase of the Moon (new moon, first quarter, full moon, etc).

3) probably the instrument had pointers for the planets, as well, which, as we read in ancient texts, had valuable rocks, showing their position with variable speed in a realistic movement and,

4) it was probably a clock with perpetual movement.

B) On side B of the instrument pointers predict in four complex calendars the:

1) eclipses,

a) based on a period of Saros, lasting 223 months (spiral scale)

b) the more precise period of Exeligmos lasting 54 years (small circular scale).

2) the reappearance of the moon with the same phase in the exactly the same position of the sky using

a) the 19-year period of Meton (which is used for the Orthodox Easter) on a spiral scale

b) the Callippic period of 76 years in a small circular scale.

3) the years of Crown Games: Olympic, Nemean, Pythian, Isthmian games, on a small circular scale.

The mechanism has a user's manual with instructions with many astronomical terms and references in particular to the movement of planets and possibly instructions for taking measurements, which are written on every available surface of the brass plates of the cover.

It is the only scientific instrument that has survived prejudice and recycling of copper and bronze that were very valuable in ancient times. It is an astronomical instrument much more advanced than any astronomical clock from those appearing after the 14th century in Western Europe. The mechanism determines the position of the Moon using variable realistic movement based on epicycles initially developed by Apollonius and Hipparchus. The Mechanism has its roots in the tradition of Thales, Aristarchus, Apollonius, Eratosthenes, notably Archimedes and Hipparchus, a tradition which was continued by Posidonius, in the Byzantine era and later in Europe after the 14th century.

The Mechanism and our exhibition at NASA

Exhibitions around the World.

I have made or contributed to many exhibitions on the Antikythera Mechanism, the oldest computer and the History of Greek astronomy is addressed to pupil and the general public. We have had several exhibitions or contributed to exhibitions: New York (Children Museum of Manhattan), the NASA Kennedy Space Center during the launch of Juno spacecraft, Drexel University, Slovakia, Slovenia, State Museum of Architecture Moscow, Moscow Science Festival, Moscow State University (Lomonosov), University of Birmingham, University of Reading, University of London (Goldsmiths College) at UNESCO (Paris, beginning of the International Year of Astronomy 2009, Upsala Gustavianum Museum (the exhibition doubled the number of visitors in the year), Library of Alexandria, Institute of Astronomy of the Slovac Academy, Olsztyn Planetarium (Copernicus observatory in Poland), Warsaw University, Budapest, the Greek School of Cairo, the Greek School of Alexandria (Egypt), Constantine (7eme salon' astronomie, Algeria), Moscow, Instituto Veneto per Science, Lettere ed Arte (Venice), Portugal, Toulouse, Universidad National Mexico, (Museum Universum) University of Sonora (both are travelling exhibitions around Mexico) and very many in Greece, at the Ionian Center, The University of Athens, University of Patras, at the Stadium Erinis and Philias at numerous schools (in Greece, The U.K., France and Egypt) and summer schools.

.

Professor in Space Physics (retired).
He has served for many years as-Head of Space Physics group, as Director of the Astrophysics Laboratory, as-Director of the Observatory of the University of Athens, as senator of the University, as Deputy President of the Faculty of Physics, as President of the Union of Professors in Science, as a member of the governing body of Hellenic Physical Society.
National and Kapodistrian University of Athens, Panepistimiopolis, GR 15783 Zographos, Athens, Greece, +30 6978792891
Former visiting senior research fellow of Imperial College of Science, Technology and Medicine (for two decades)
Visiting professor at the University of Mexico (UNAM) for three monthly visits.
e-mail: xmoussas@phys.uoa.gr

Research interests:
Space physics, Participation in Ulysses (ESA/NASA), STEREO (NASA) mission and WIND/WAVES, SWAVES experiment (co-investigator and team member), Cosmic ray modulation and the heliosphere, Magnetospheric and planetary physics, Solar physics, ROSAT (Röntgensatellit), construction of the magnetic shield of the U.K. wide field camera, Chaos and non-linear phenomena, History of Astronomy, study of the Antikythera Mechanism, the oldest computer , and Ancient Greek Celestial Spheres (8th c BC).
Supervisor of 35 Ph.D. students (three with Observatoire de Paris), many M.Sc. and 250 theses of undergraduate students.
Teaching: Astrophysics, Astronomy, and Space Physics (undergraduate and MSc level) courses.
Publications:

- Author of "Antikythera Mechanism, PINAX", Greek Physical Society Publishing House, Athens, 2011, 2012.
- Antikythera Mechanism, the oldest computer and mechanical Cosmos, Canto Mediterraneo, 2018
- Co-author of "Space Physics", Greek Open University Publishing House, Patras, 2003.
- Notes for students: Astrophysics, Laboratory Exercises for Astrophysics, Space Physics, University of Athens.
- Approximately 110 articles in international Journals and many in conferences.
- Many reviews, interviews and presentations in Greek scientific magazines and daily papers.
- More than 150 articles in encyclopedias (all the astronomical articles in the *Ekdodike Athinon Thematic Encyclopedia*).
- Many popular science articles
- Many Radio and TV programs and interviews
- Co-Editor (1979-81) of "Physicos Cosmos", the popular science magazine of the Greek Physical Society.
- Editor (1997-99) of "Hipparcos", the Hellenic Astronomical Society bulletin.

Awards include:
1) Geophysical Research Letters editor's citation for excellence in refereeing in Space Physics, American Geophysical Union, Boston, 2001
2) NASA award for participation in EPAC/Ulysses experiment, 2009
3) Hipparchus award, Arcadia Cultural Organization, Athens, Greece, 2010

4) Award of Tutorial School Association of Greece, for the work on Antikythera Mechanism, 2017
5) Honorary doctor of the International Academy of Education and Science,Ukranian Institue of Science and Cultural History, Pontic Institute, Ukraine, 2017.

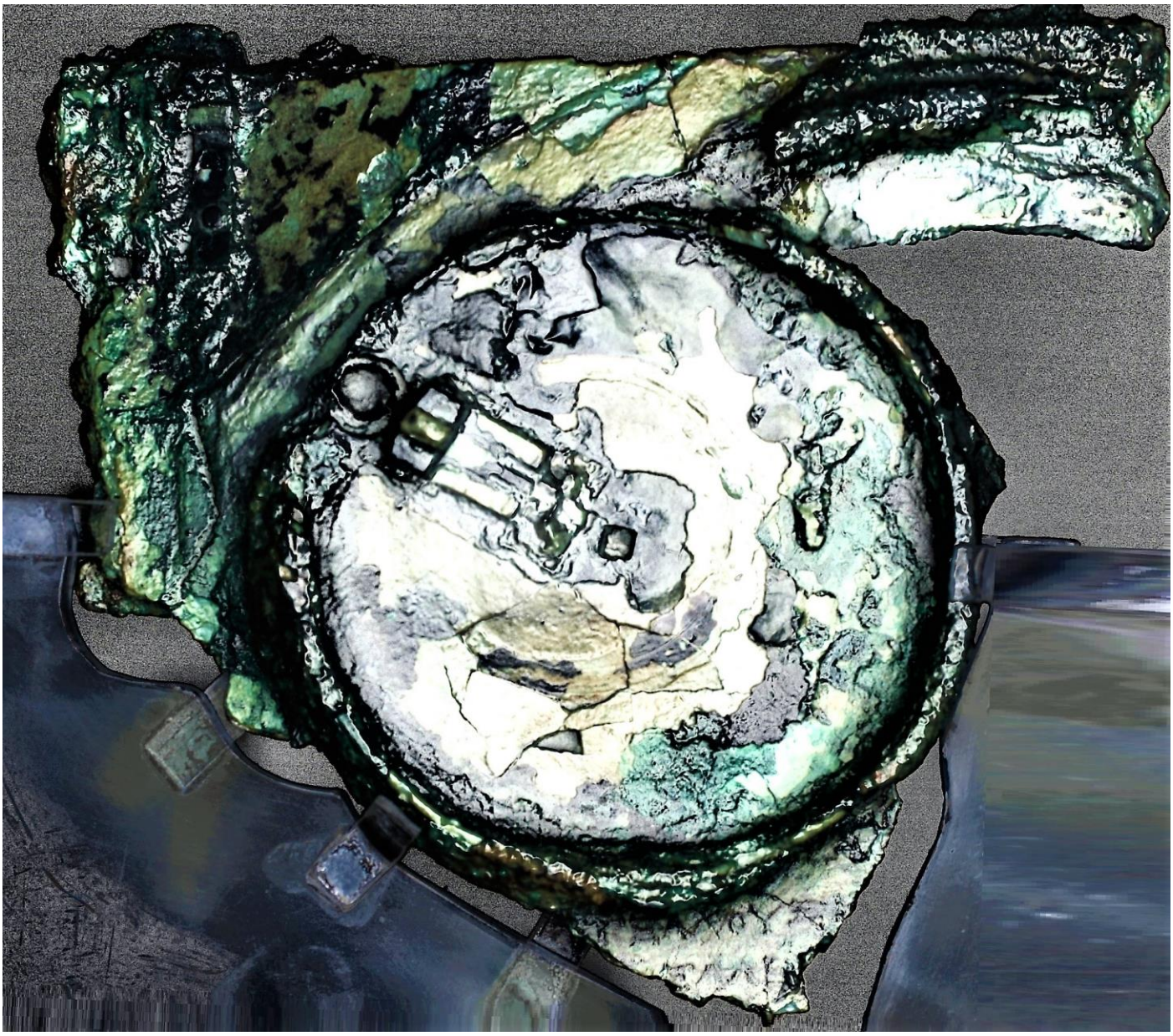

Image 11 The lunar mechanism. The lunar speed follows an approximationof Kepler second law.