IL MECCANISMO DI ANTIKYTHERA A MILANO

Con la gentile collaborazione degli Organizzatori

AMBASCIATA DI GRECIA ROMA
UFFICIO PER GLI AFFARI ECONOMICI E COMMERCIALI A MILANO

ISTITUTO ELLENICO di CULTURA

Università Nazionale e Capodistriana di Atene
National and Kapodistrian University of Athens
Εθνικό και Καποδιστριακό Πανεπιστήμιο Αθηνών

Il meccanismo di Anticitera: Il Coreografo Meccanico del Cosmo e i cicli olimpici

The Antikythera Mechanism: The Geared Choreographer of the Cosmos and the Olympic Cycles

Ο Μηχανισμός των Αντικυθήρων: Ο μηχανικός χορογράφος του Κόσμου και οι Ολυμπιακοί Κύκλοι

Xenophon Moussas
xmoussas@phys.uoa.gr xdmoussas@gmail.com

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Nell'ambito di

Cultural OLYMPIAD — THE ARTS PROGRAMME

PATROCINIO Comune di Milano

Iniziativa inserita nell'ambito dell'Olimpiade Culturale di Milano Cortina 2026

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ISTITUTO ELLENICO di CULTURA

"Il Meccanismo di Antikythera ponte della cultura tra Italia e Grecia"

Civico Planetario Ulrico Hoepli | 4 Febbraio - 16 Marzo 2026

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Nell'ambito di

Cultural Olympiad 26 THE ARTS PROGRAMME

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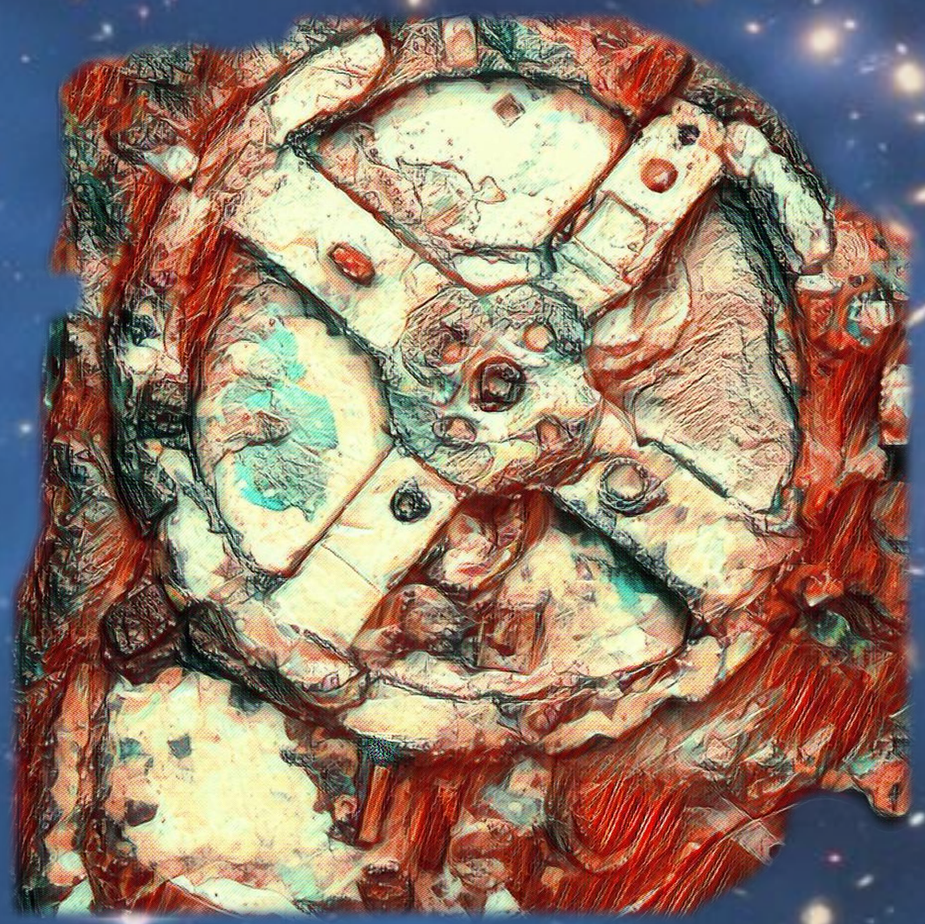

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PATROCINIO Comune di Milano

Iniziativa inserita nell'ambito dell'Olimpiade Culturale di Milano Cortina 2026

Grazie mille

Ambasciata greca a Roma,
Ufficio per gli Affari Economici e Commerciali,
signora B. Larda
Istituto Ellenico di Cultura
Signor Nikos Frangos
Planetario di Milano
Professor Fabio Peri
Museo della Scienza
Comune di Milano.

Many thanks
Greek Embassy in Rome,
Office of Economic and Commercial Affairs,
Mrs. B. Larda
Institute of Greek Culture
Mr. Nikos Frangos
Milan Planetarium
Professor Fabio Peri
Science Museum
Municipality of Milan.

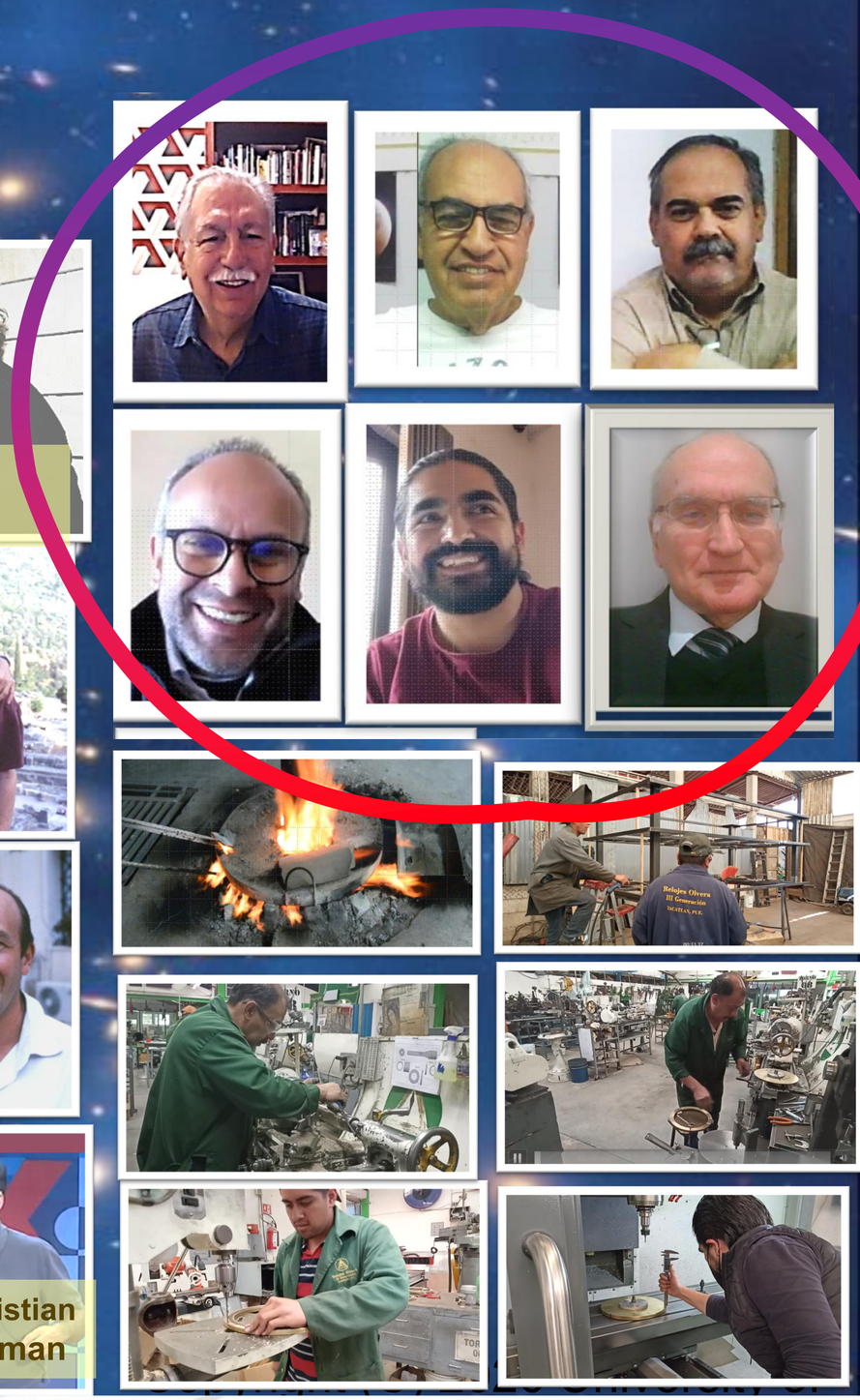
Πολλές ευχαριστίες
Ελληνική Πρεσβεία στην Ρώμη, Γραφείο Οικονομικών και Εμπορικών Υποθέσεων,
κα Μπέττυ Λάρδα
Ινστιτούτο Ελληνικού Πολιτισμού
κο Νίκο Φράγκο
Πλανητάριο του Μιλάνου
καθηγητής κύριος Fabio Peri
Μουσείο Επιστημών
Δήμο Μιλάνου.

Οι επιστημονικές μας ομάδες
Questo è il lavoro di un team, una collaborazione.
This is the work of a team, a collaboration

una colaboración

Collaboration!

Συνεργασία!



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Nell'ambito di

Cultural OLYMPIAD 26 — THE ARTS PROGRAMME

PATROCINIO Comune di Milano

Iniziativa inserita nell'ambito dell'Olimpiade Culturale di Milano Cortina 2026

Universidad de Sonora
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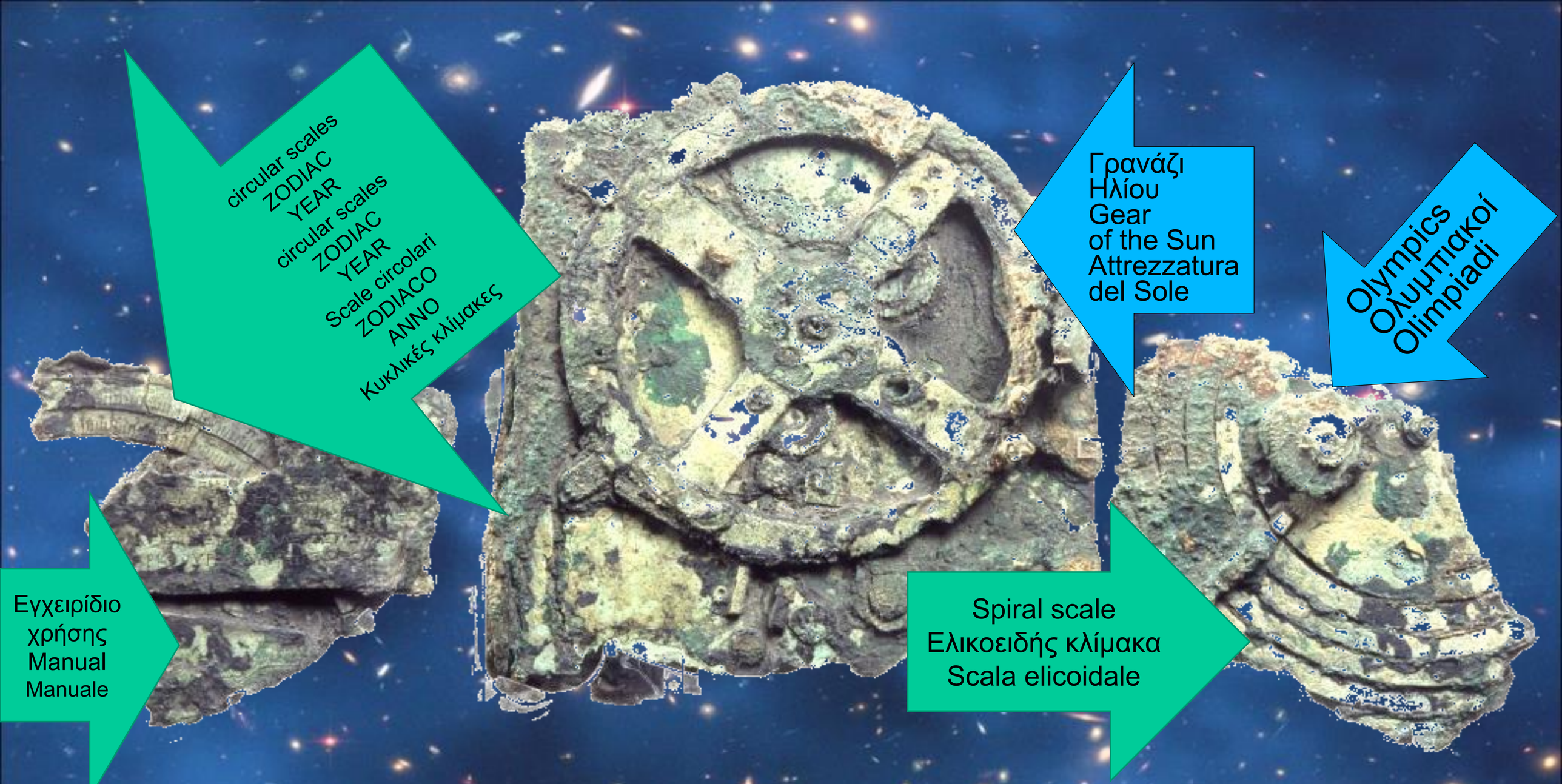

- **The three largest fragments of the 82 pieces of the Antikythera Mechanism. When you come to Athens,**
- **I will be very happy to show you the Mechanism at the National Archaeological Museum, Athens**

- **I tre frammenti più grandi degli 82 pezzi del Meccanismo Quando verrai ad Atene, sarò molto felice di mostrarti il Meccanismo al Museo Archeologico Nazionale di Atene**

- **Τα τρία μεγαλύτερα θραύσματα από τα 82 κομμάτια του Μηχανισμού των Αντικυθήρων. Όταν έρθετε στην Αθήνα, θα χαρώ πολύ να σας δείξω τον Μηχανισμό στο Εθνικό Αρχαιολογικό Μουσείο, Αθήνα**

Il Meccanismo è un computer meccanico analogico e digitale di piccole dimensioni. Funziona con ingranaggi che eseguono calcoli matematici che prevedono fenomeni astronomici, ad esempio dove sarà la Luna stasera alle 22:00, quando ci sarà un'eclissi solare o lunare, ecc.

Ο Μηχανισμός είναι ένας μικρού μεγέθους μηχανικός αναλογικός και ψηφιακός υπολογιστής. Λειτουργεί με γρανάζια που εκτελούν **μαθηματικούς υπολογισμούς** που **προβλέπουν αστρονομικά φαινόμενα**, π.χ. πού θα είναι η Σελήνη απόψε στις 10 μ.μ., πότε θα έχουμε έκλειψη Ηλίου ή Σελήνης κ.λπ.

The Mechanism is a small mechanical analog and digital computer. It works with gears.
The gears perform mathematical calculations, based on Pythagorean Philosophy, <u>that predict astronomical</u> phenomena, e.g. where will the Moon be tonight at 10 pm, when will we have an Eclipse of the Sun or Moon etc.

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- Previsione delle eclissi,
- Fasi lunari,
- Calendario lunare Ciclo metonico (il calendario di Pasqua)
- Giochi olimpici e altri giochi

- Prediction of eclipses,
- Lunar phases,
- Lunisolar calendar Metonic cycle (the calendar of Easter, Passover)
- Olympic and other games

- Πρόβλεψη εκλείψεων,
- Σεληνιακές φάσεις,
- Σεληνιακό ημερολόγιο Μετονικός κύκλος (το ημερολόγιο του Πάσχα)
- Ολυμπιακοί και άλλοι αγώνες

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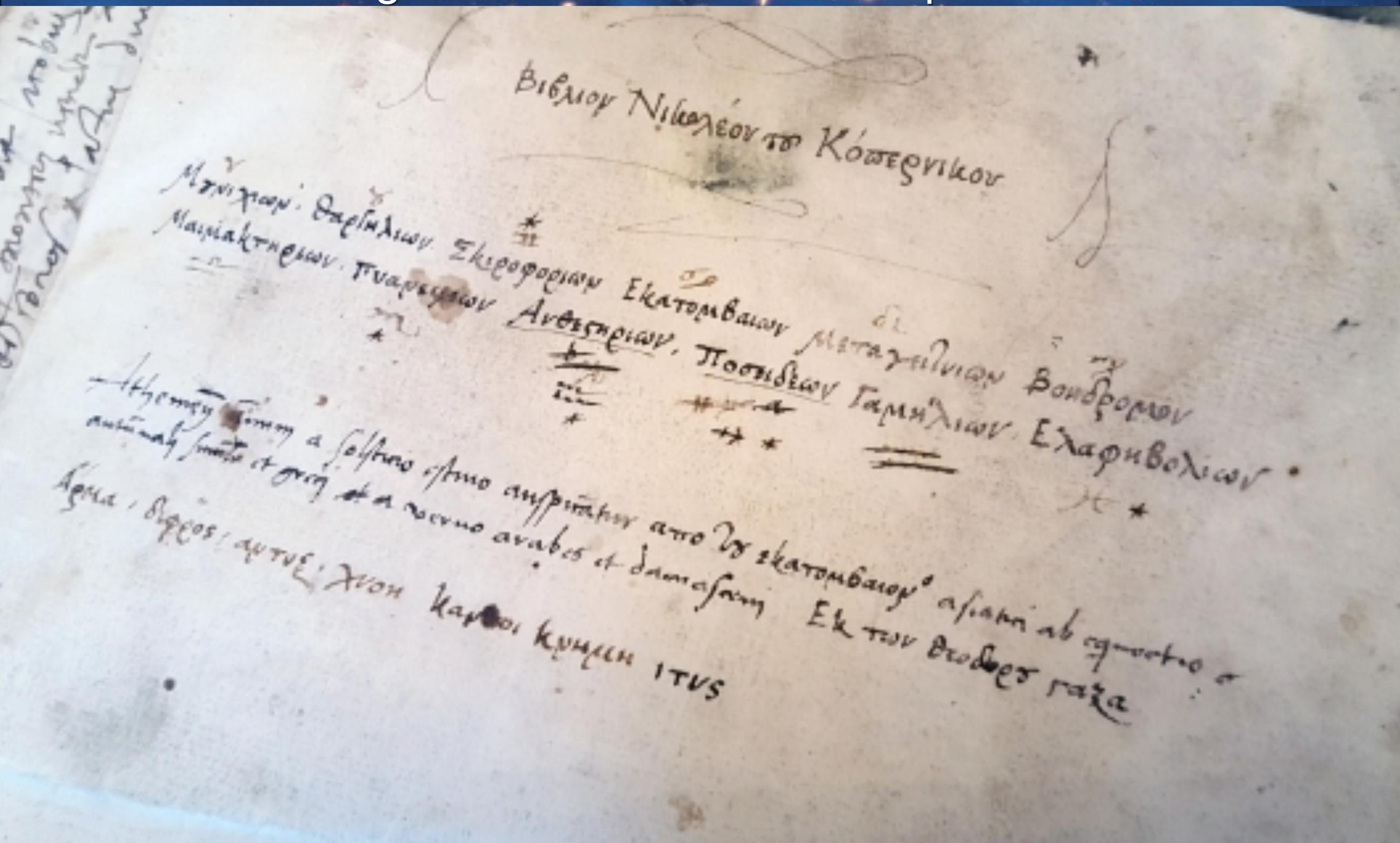
The text in Greek: “book of Nikolaos Kopernikos”
It contains the months of one of the calendars of the Antikythera Mechanism.
Contiene i mesi di uno dei calendari del Meccanismo di Anticitera.Il testo greco: "libro di Nikolaos Kopernikos"



Βιβλιον Νικολεον του Κοπερνικον

Μουνιχιων. Θαργηλιων Σκιροφοριων Εκατομβαιων μεταγειτνιων βοηδρομιων
Μαιμακτηριων. Πυανεψιων Ανθεστηριων. Ποσειδεων Γαμηλιων. Ελαφηβολιων

(Attican caledar) Μουνιχιών, Θαργηλιών, Σκιροφοριών, Έκατόμβαιών, Μεταγειτνιών, Βοηδρομιών, Πυανέψιών, Μαιμακτηριών, Ποσειδεών, Γαμηλιών, Ανθεστηριών, Ελαφηβολιών,

Από του Εκατομβαιών

Εκ των Θεοδώρου Γάζα (;)

Άρμα, δίφρος, άρτος, χιών ;

Nicolaus Copernicus' books
digitized - Uppsala University
https://www.uu.se/en/news/2017/2017-04-06-nicolaus-copernicus-books-digitized
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National Archaeological Museum, Athens
Εθνικό Αρχαιολογικό Μουσείο

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Elias Stadiatis, the sponge diver who discovered the shipwreck and the Mechanism

Elias Stadiatis, il subacqueo delle spugne che scoprì il relitto e il Meccanismo

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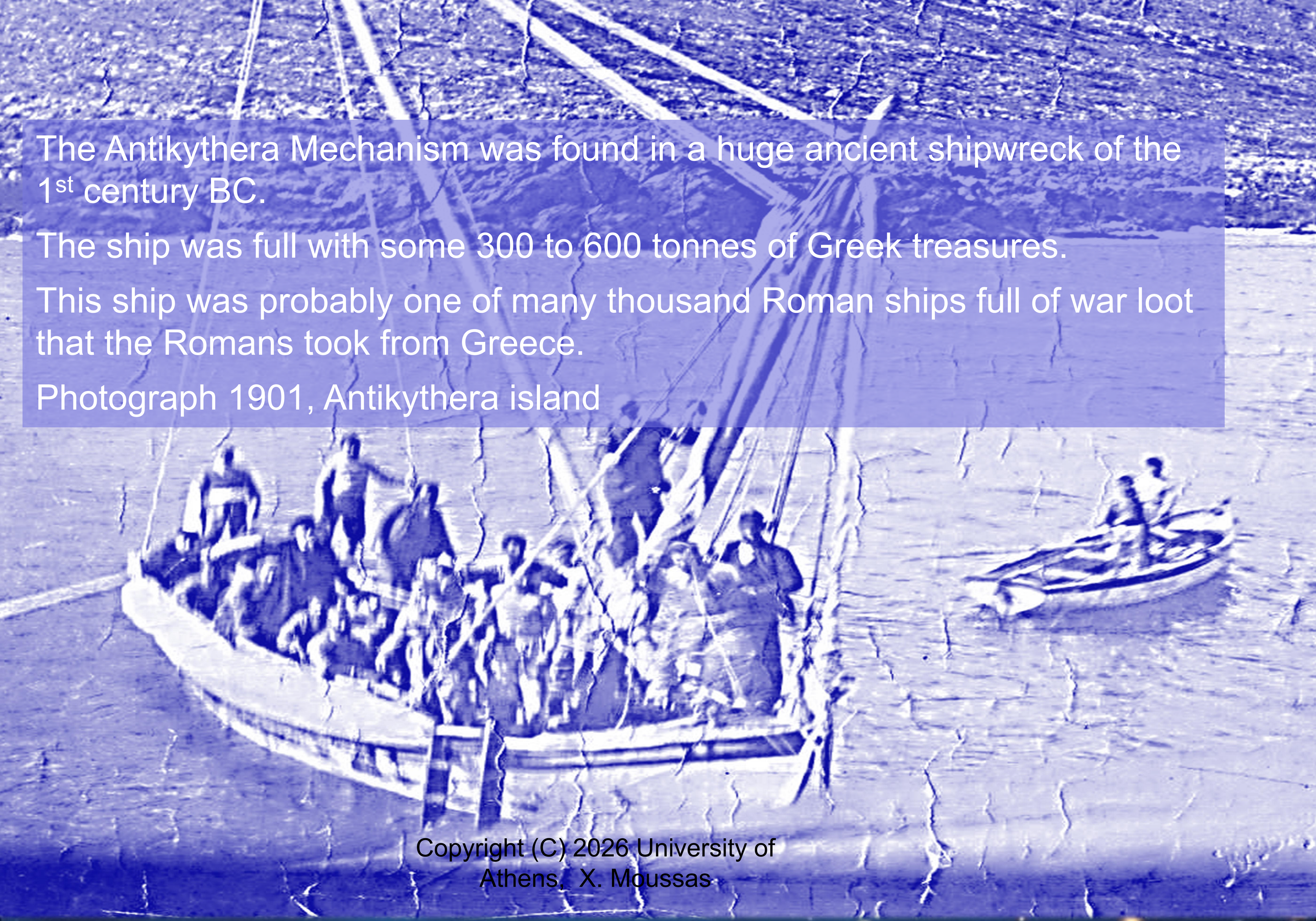

The Antikythera Mechanism was found in a huge ancient shipwreck of the 1st century BC.

The ship was full with some 300 to 600 tonnes of Greek treasures.

This ship was probably one of many thousand Roman ships full of war loot that the Romans took from Greece.

Photograph 1901, Antikythera island

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the ship owner with the family c. 1900

L'armatore (iniziatore) Fotis Lendiakos con la sua famiglia Symi ~1900

Ο Εφοπλιστής (εκκινητής) Φώτης Λενδιακός με την οικογένειά του Σύμη ~1900

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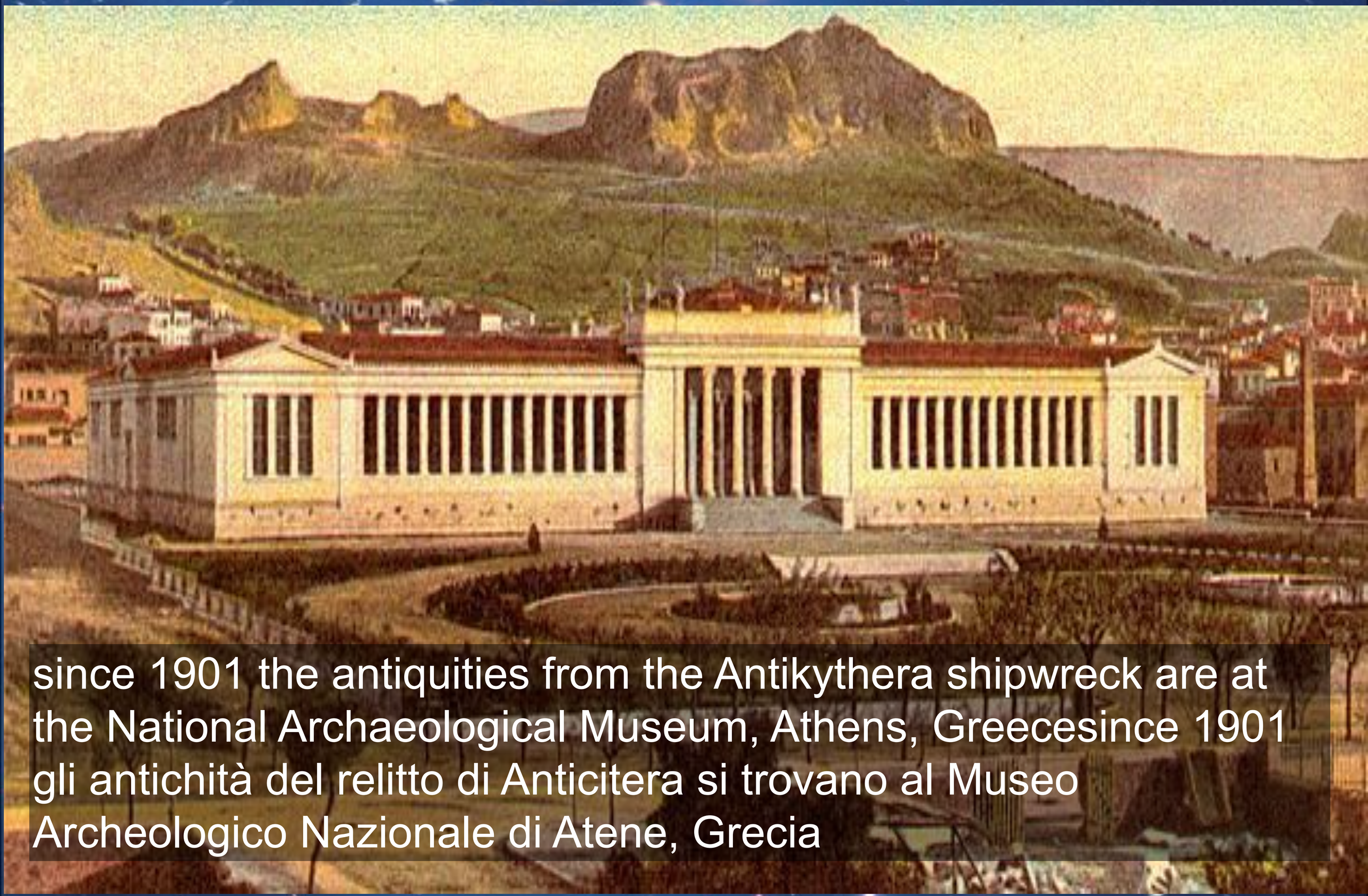

since 1901 the antiquities from the Antikythera shipwreck are at the National Archaeological Museum, Athens, Greecesince 1901 gli antichità del relitto di Anticitera si trovano al Museo Archeologico Nazionale di Atene, Grecia

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Two excellent bronze statues

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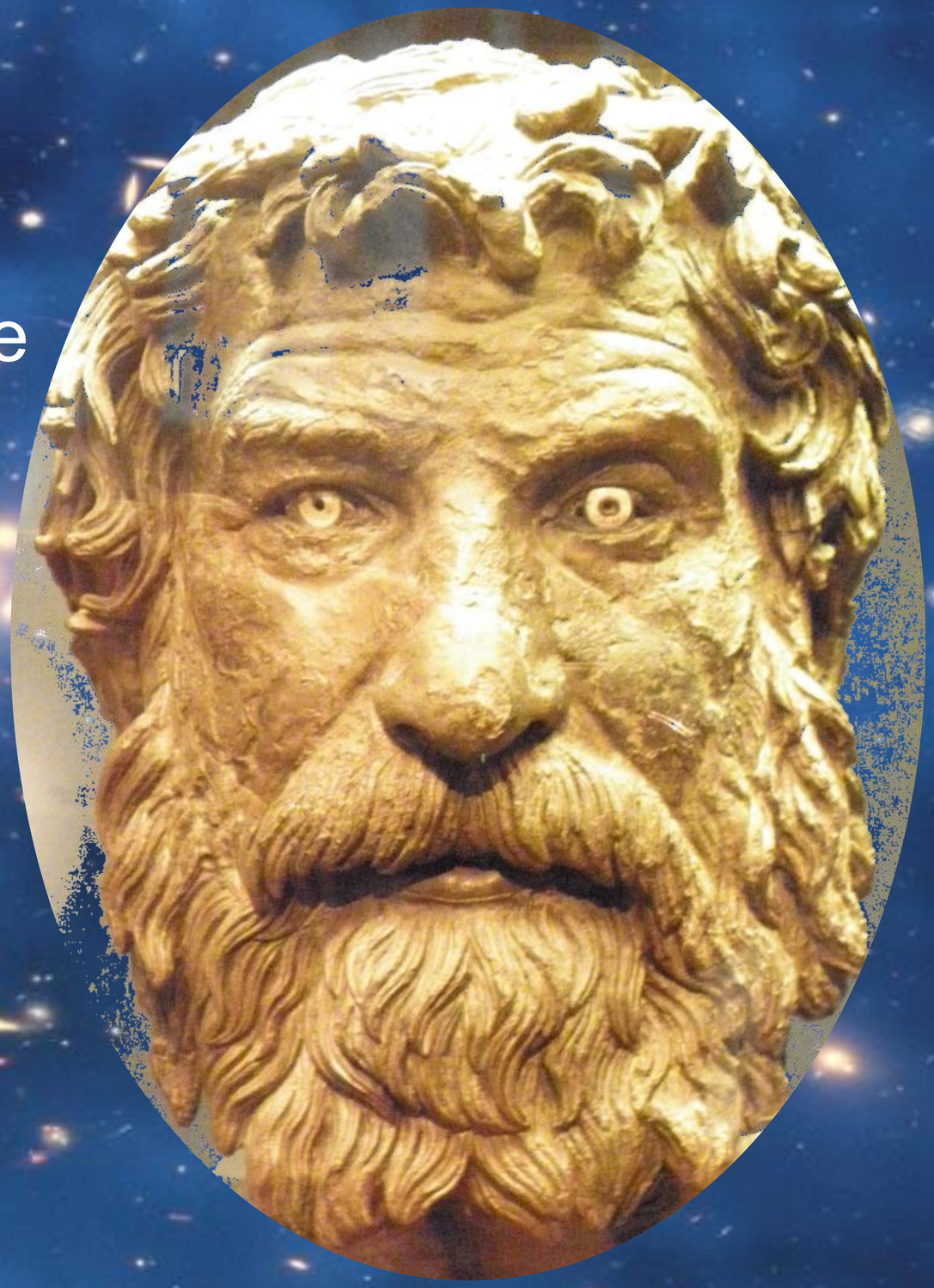
Here we see the head of the Antikythera Philosopher which is a very impressive statue



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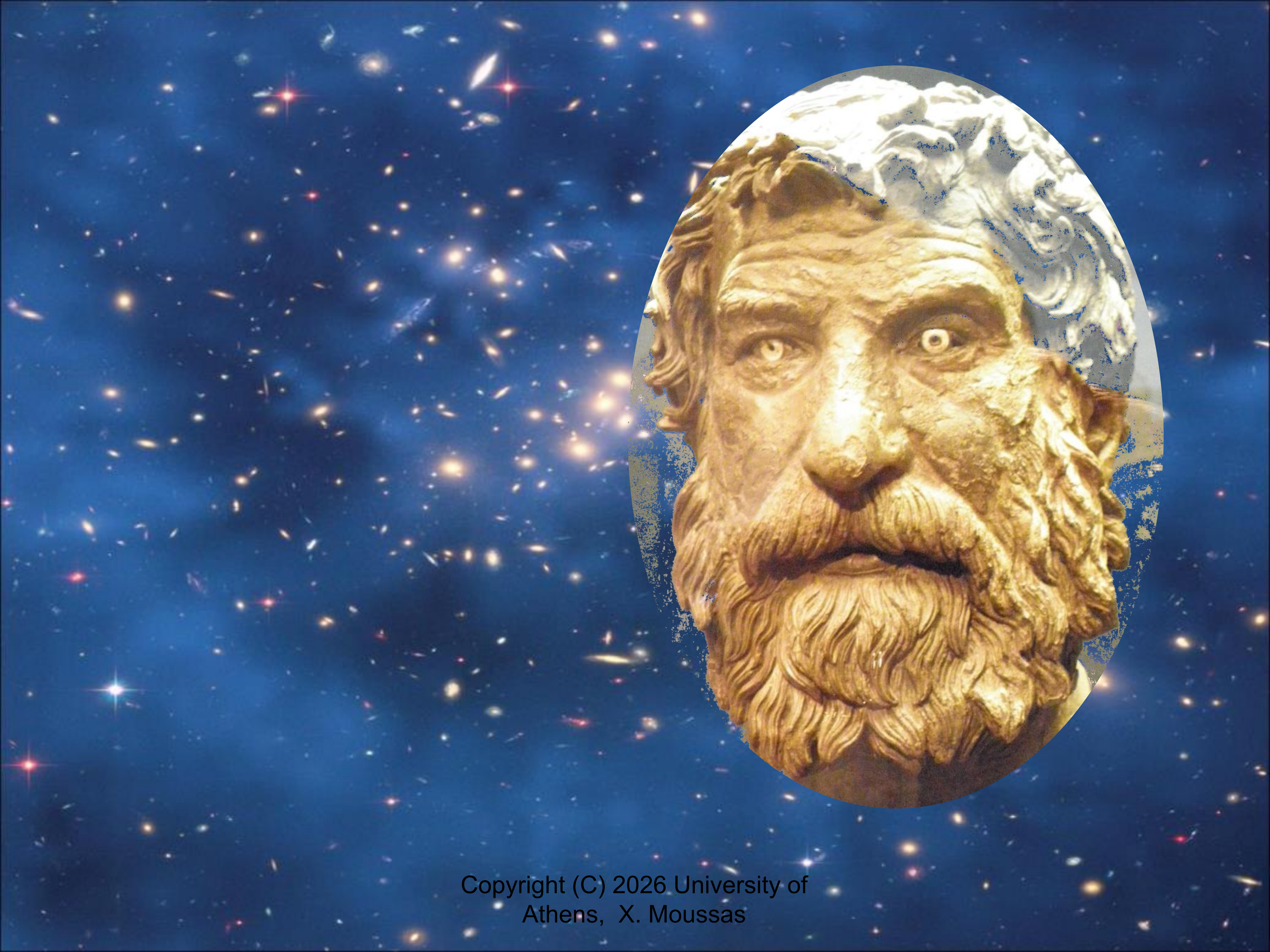

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- il Giovane di Anticitera, probabilmente Perseo che teneva la testa di Medusa (o il Meccanismo di Anticitera?)
- o Parigi che offre la mela a Venere

- the *Antikythera Youth*, probably Perseus holding the head of Medusa (or the Antikythera Mechanism?)
- or Paris offering the apple to Venus

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and the *Antikythera Youth*, probably Perseus holding the head of Medusa (or the Antikythera Mechanism?)

or Paris offering the apple to Venus

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- A Farnese Hercules

Έπιπλα, Louis XIV

The ship had several luxurious sofas (Louis XIV like)

They have recently discovered more

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Murano?

precious glasswork have been found the ship, dated circa 75 BC

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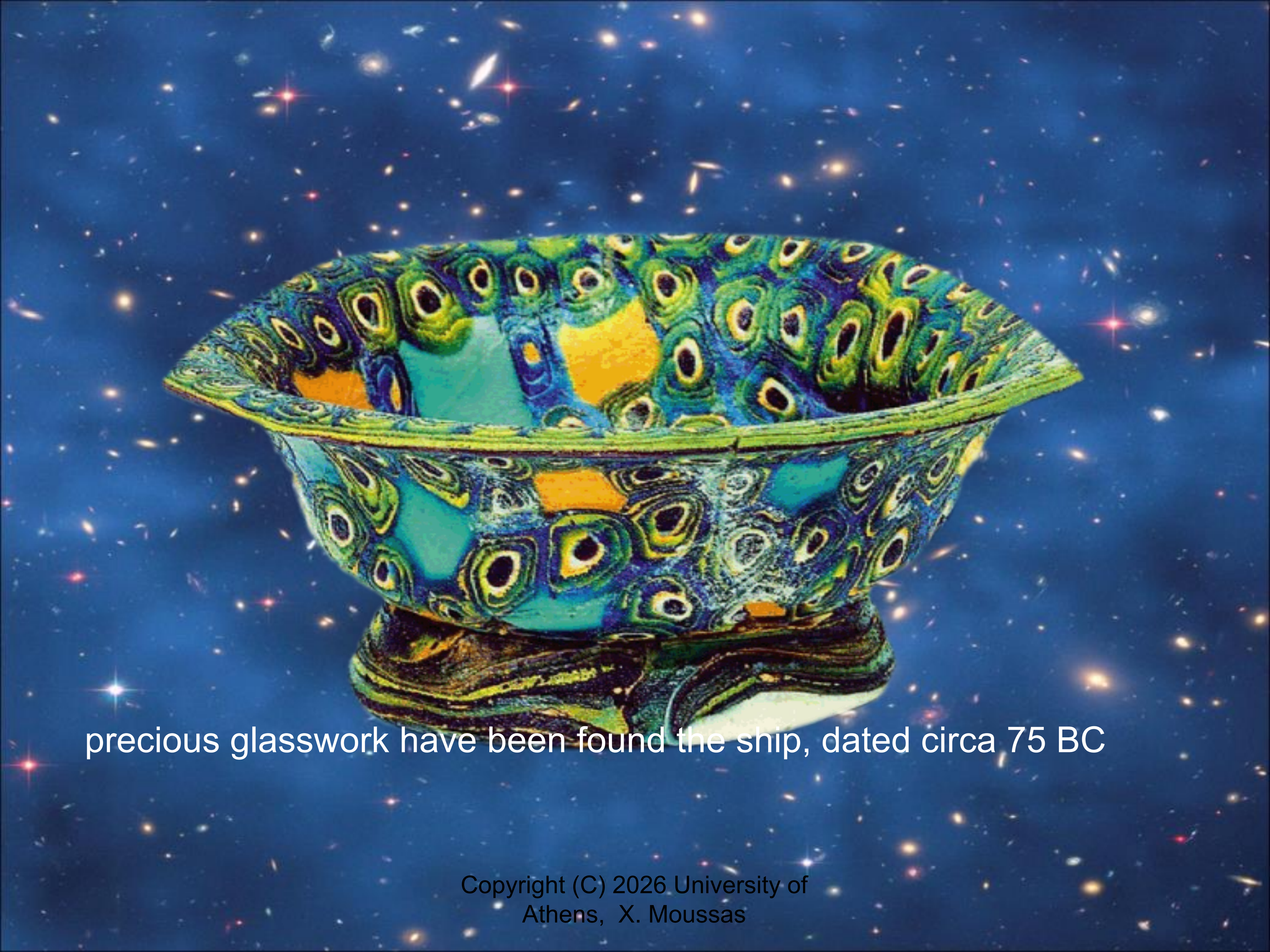

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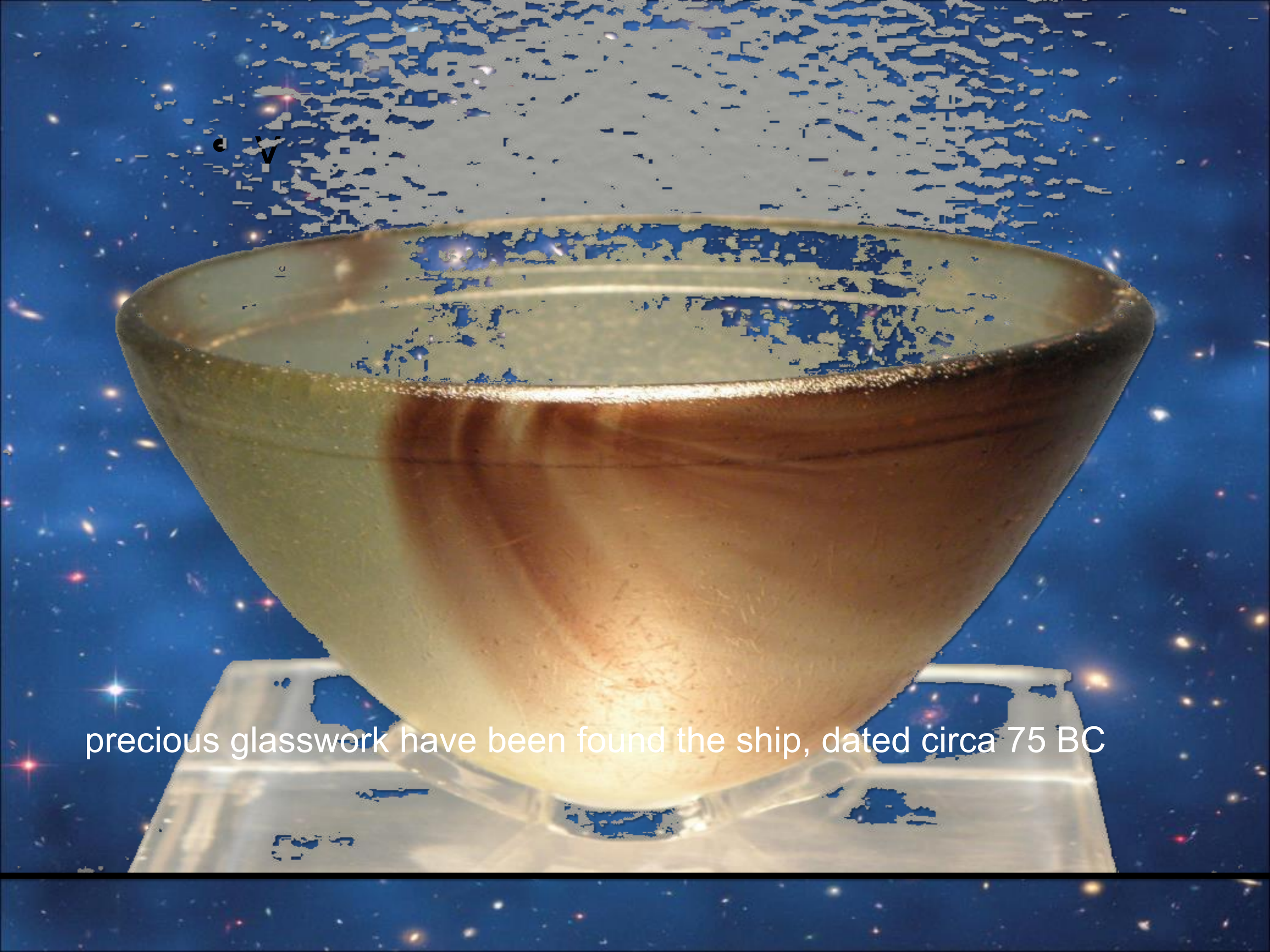
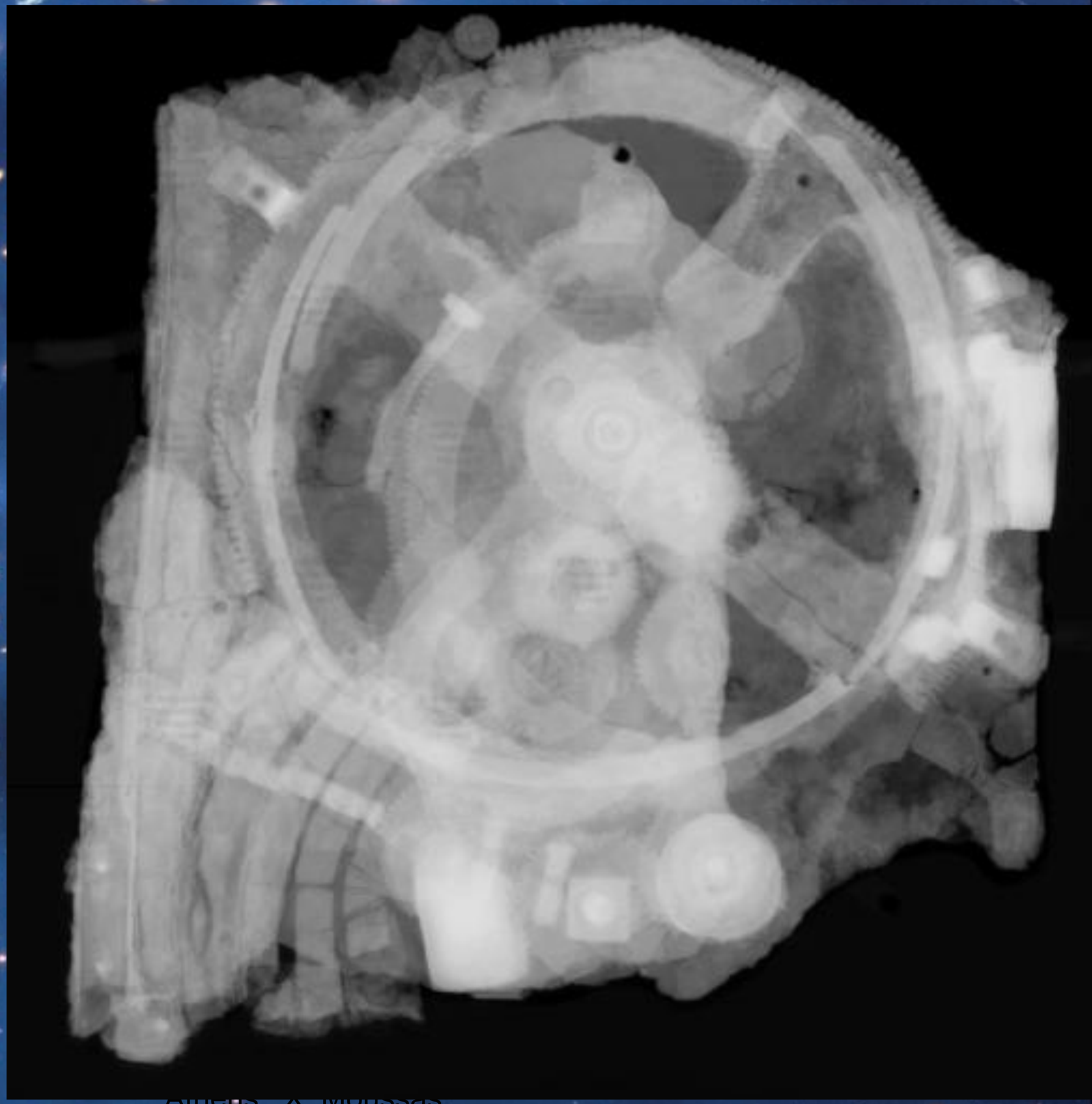


precious glasswork have been found the ship, dated circa 75 BC

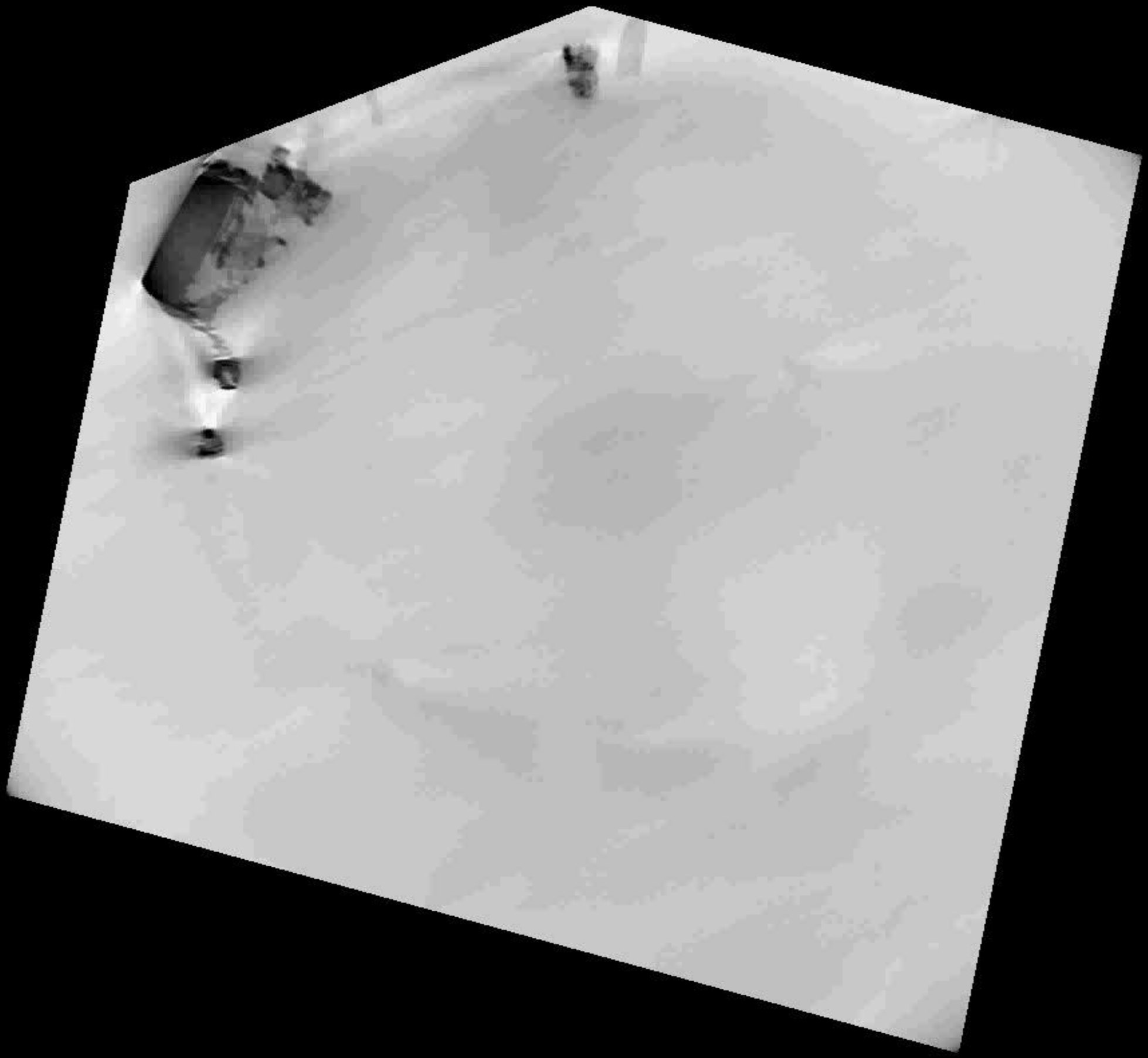
precious glasswork have been found the ship, dated circa 75 BC

Radiography of the largest fragment, the gear of the Sun
Ακτινογραφία του μεγαλύτερου θραύσματος με το γρανάζι του Ήλιου.



Athens, X. Moussas

Η ομάδα μελέτης του Μηχανισμού των Αντικυθήρων, X-TEK, Nikon Metrologies



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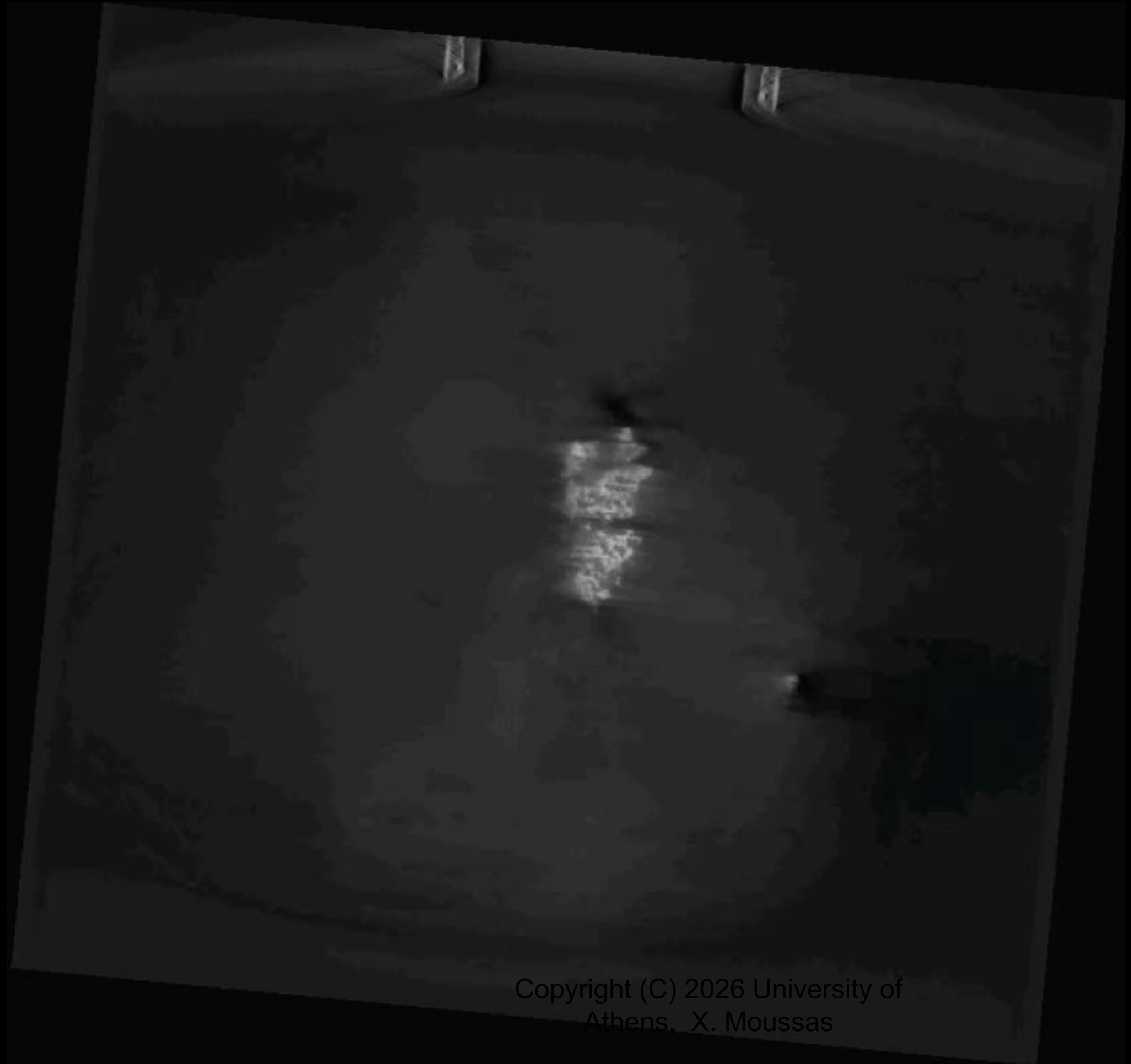

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VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

File Edit Object Scene Presets Tools Window Help

NONE

Axial (xy slice) : 157%

Light properties

Overall intensity 33.0

Front light source

ambient: 33

diffuse: 33

Shadow light source

ambient: 33

diffuse: 33

Object properties

Rot Scale Clip Center

Rotation (scene coordinates)

X: 0.000

Y: 0.000

Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

2.97

instrument position: < 21 19 281 > 4.206 3.857 56.296 value: 2890 mm not calibrated size: 1³ 0%

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VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

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Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

3.77

instrument position: < 21 19 281 > 4.206 3.857 56.296 value: 2890 mm not calibrated size: 1² 0%

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Advanced

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Classification

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Opacity manipulation area

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Grayvalues

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4.57

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VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

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diffuse: 33

Shadow light source

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Object properties

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Y: 0.000

Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

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Opacity manipulation area

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Color manipulation area

4.97

instrument position: < 21 19 281 > 4.206 3.857 56.296 value: 2890 mm not calibrated size: 1² 0%

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VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

File Edit Object Scene Presets Tools Window Help

Axial (xy slice) : 157%

Light properties

Overall intensity 33.0

Front light source

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diffuse: 33

Shadow light source

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Object properties

Rot Scale Clip Center

Rotation (scene coordinates)

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Classification

Preset selection

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Opacity manipulation area

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Grayvalues

Color manipulation area

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instrument position: < 21.19 281 > 4.206 3.857 56.296 value: 2990 mm not calibrated size: 1° 0%

VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

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NONE

Axial (xy slice) : 157%

Light properties

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diffuse: 33

Shadow light source

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Object properties

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Reset Apply

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Preset selection

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Opacity manipulation area

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Grayvalues

Color manipulation area

0.57

instrument position: < 21 19 281 > 4.206 3.857 56.296 value: 2890 mm not calibrated size: 1² 0%

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NONE

Axial (xy slice) : 157%

Light properties

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diffuse: 33

Shadow light source

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diffuse: 33

Object properties

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Rotation (scene coordinates)

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Z: 0.000

Advanced

Reset Apply

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Preset selection

NONE

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Opacity manipulation area

section 1

Grayvalues

Color manipulation area

-0.83

instrument position: < 21 19 281 > 4.206 3.857 56.296 value: 2890 | mm | not calibrated | size: 1² | 0%

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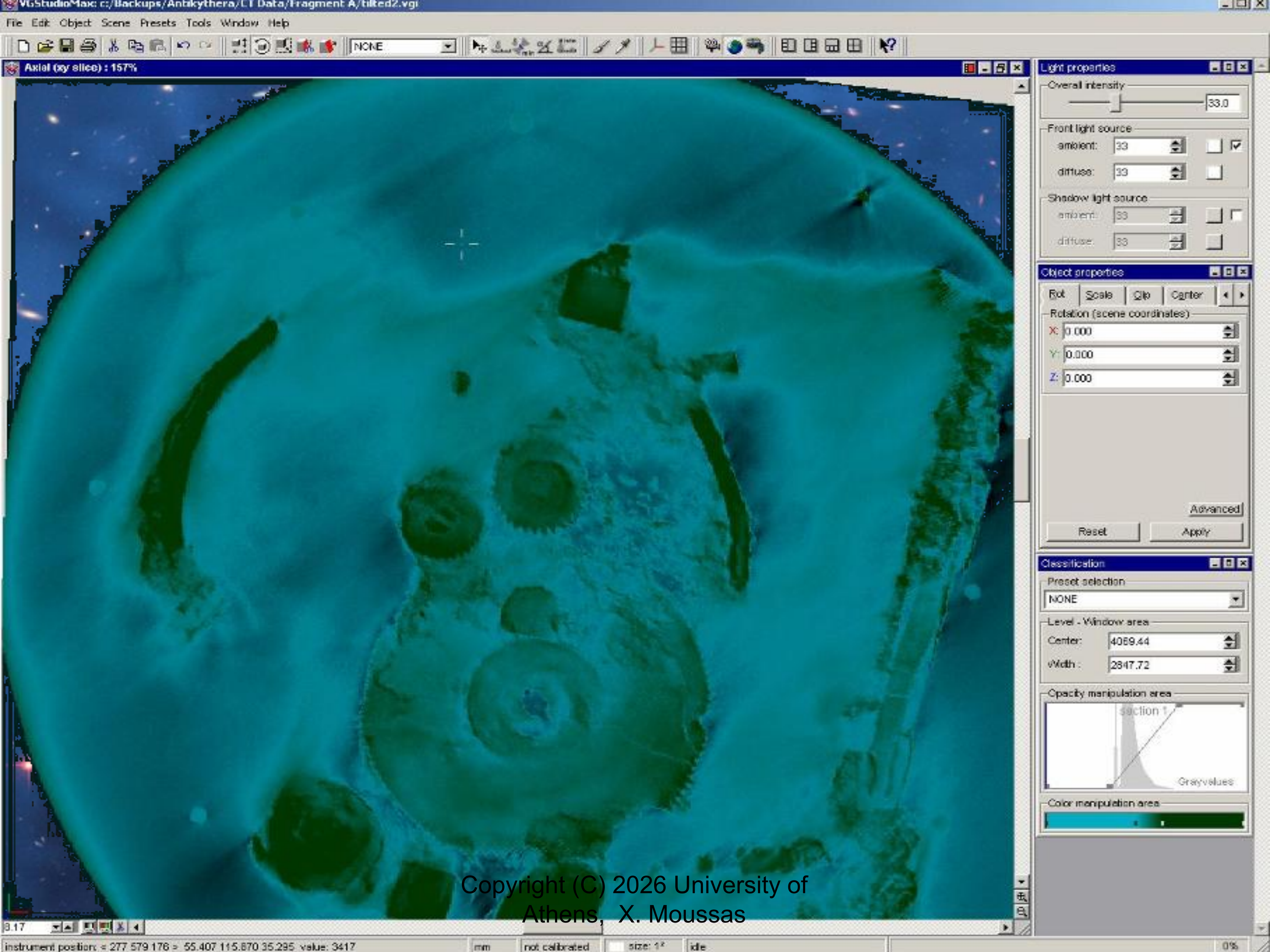

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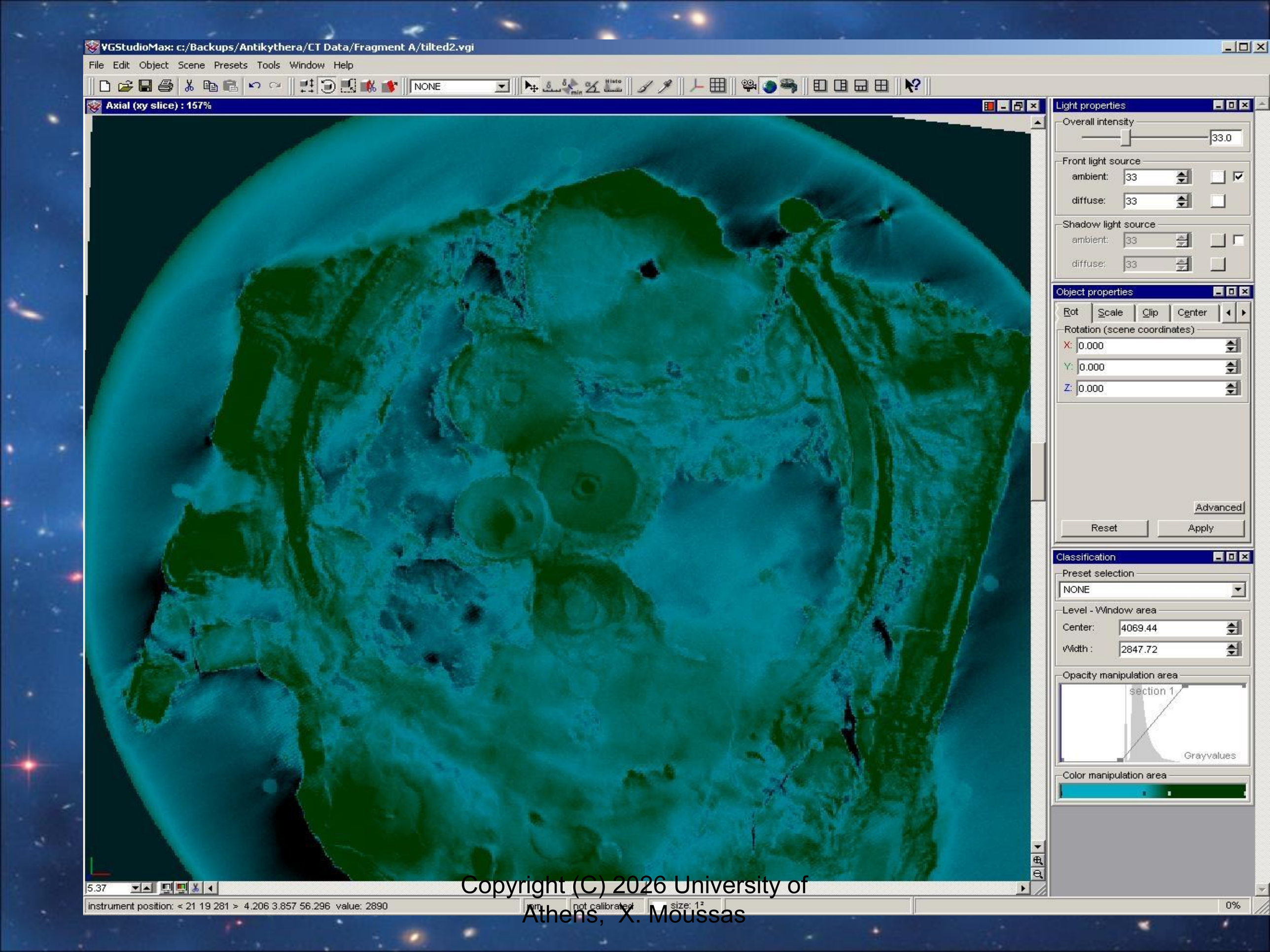

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Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

6.17

instrument position: < 21 19 281 > 4.206 3.857 56.296 value: 2890 mm not calibrated size: 1 0%

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Rotation (scene coordinates)

X: 0.000

Y: 0.000

Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

7.17

instrument position: < 21 19 281 > 4.206 3.857 56.296 value: 2890 mm not calibrated size: 1² 0%

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VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

File Edit Object Scene Presets Tools Window Help

NONE

Axial (xy slice) : 157%

Light properties

Overall intensity 33.0

Front light source

ambient: 33

diffuse: 33

Shadow light source

ambient: 33

diffuse: 33

Object properties

Rot Scale Clip Center

Rotation (scene coordinates)

X: 0.000

Y: 0.000

Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

7.97

instrument position: < 21 19 281 > 4.206 3.857 56.296 value: 2890 mm not calibrated size: 1² 0%

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X: 0.000

Y: 0.000

Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

8.17

instrument position: < 277 579 176 > 55.407 115.870 35.295 value: 3417 mm not calibrated size: 1 idle 0%

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Reset Apply

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Reset Apply

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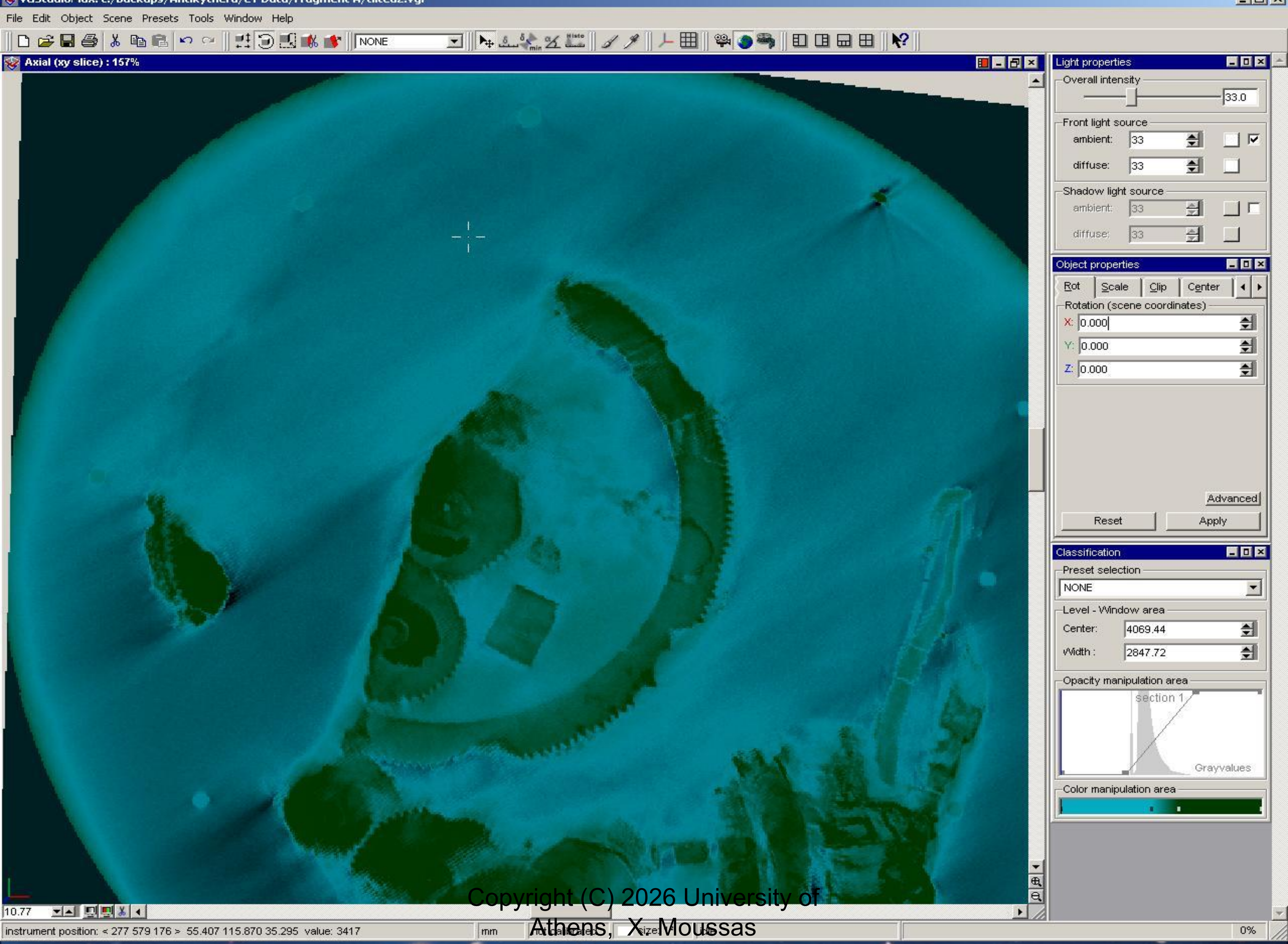

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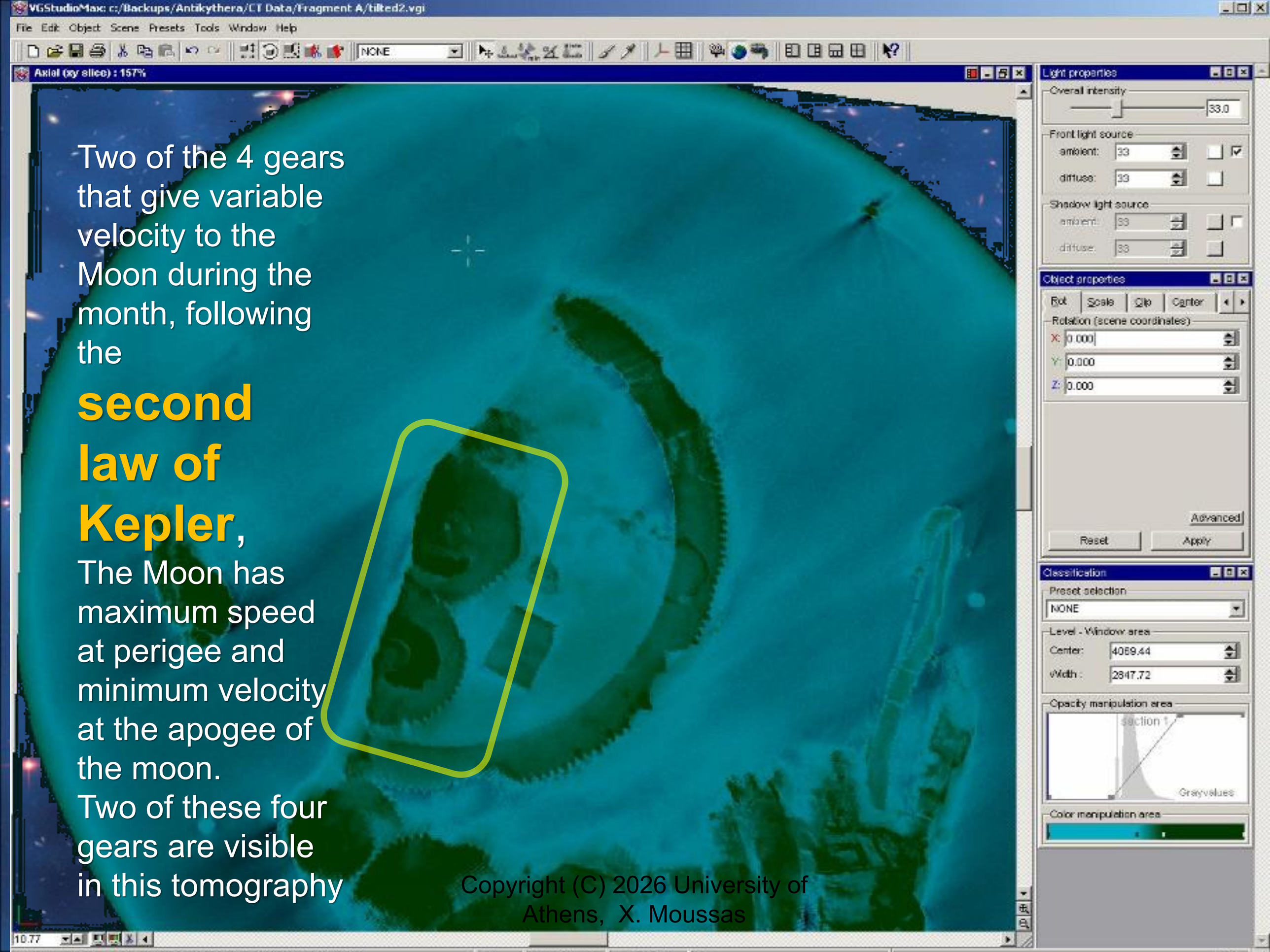

Two of the 4 gears that give variable velocity to the Moon during the month, following the

second law of Kepler,

The Moon has maximum speed at perigee and minimum velocity at the apogee of the moon.

Two of these four gears are visible in this tomography

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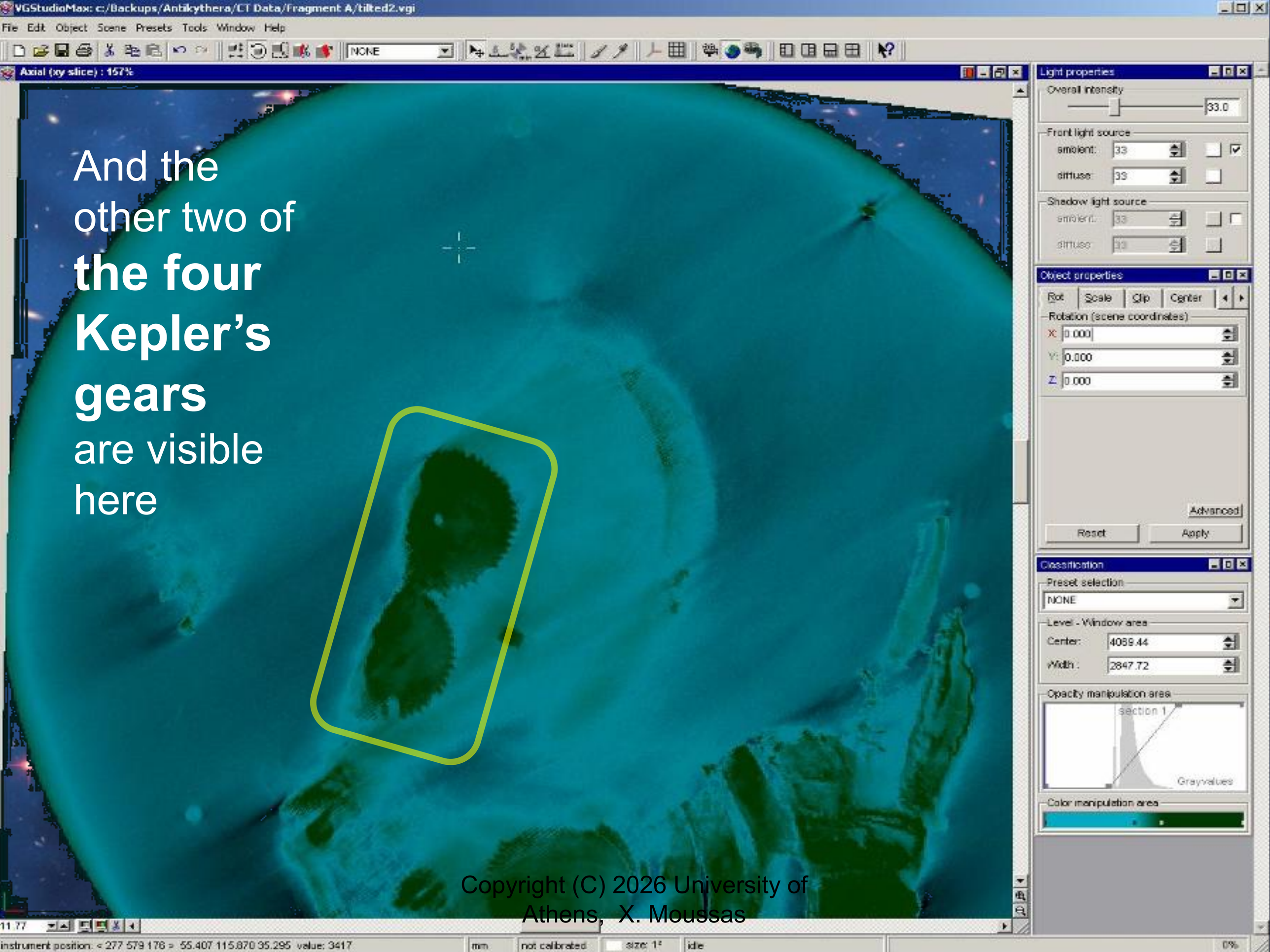
VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi
File Edit Object Scene Presets Tools Window Help
Axial (xy slice) : 157%
Light properties
Overall intensity
33.0
Front light source
ambient: 33
diffuse: 33
Shadow light source
Object properties
Rot Scale Clip Center
Rotation (scene coordinates)
X: 0.000
Y: 0.000
Z: 0.000
Advanced
Reset Apply
Classification
Preset selection
NONE
Level - Window area
Center: 4089.44
Width: 2847.72
Opacity manipulation area
section 1
Grayvalues
Color manipulation area
And the
other two of
the four
Kepler's
gears
are visible
here
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VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

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Rotation (scene coordinates)

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Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

11.77

instrument position: < 277 579 176 > 55.407 115.870 35.295 value: 3417 mm not calibrated size: 1² idle 0%

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VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

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Rotation (scene coordinates)

X: 0.000

Y: 0.000

Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

12.37

instrument position: < 277 579 176 > 55.407 115.870 35.295 value: 3417 | mm | not calibrated | size: 1² | idle | 0%

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VGStudioMax: c:/Backups/Antikythera/CT Data/Fragment A/tilted2.vgi

File Edit Object Scene Presets Tools Window Help

NONE

Axial (xy slice) : 157%

Light properties

Overall intensity 33.0

Front light source

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diffuse: 33

Shadow light source

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diffuse: 33

Object properties

Rot Scale Clip Center

Rotation (scene coordinates)

X: 0.000

Y: 0.000

Z: 0.000

Advanced

Reset Apply

Classification

Preset selection

NONE

Level - Window area

Center: 4069.44

Width : 2847.72

Opacity manipulation area

section 1

Grayvalues

Color manipulation area

12.97

instrument position: < 277 579 176 > 55.407 115.870 35.295 value: 3417 | mm | not calibrated | size: 1² | idle | 0%

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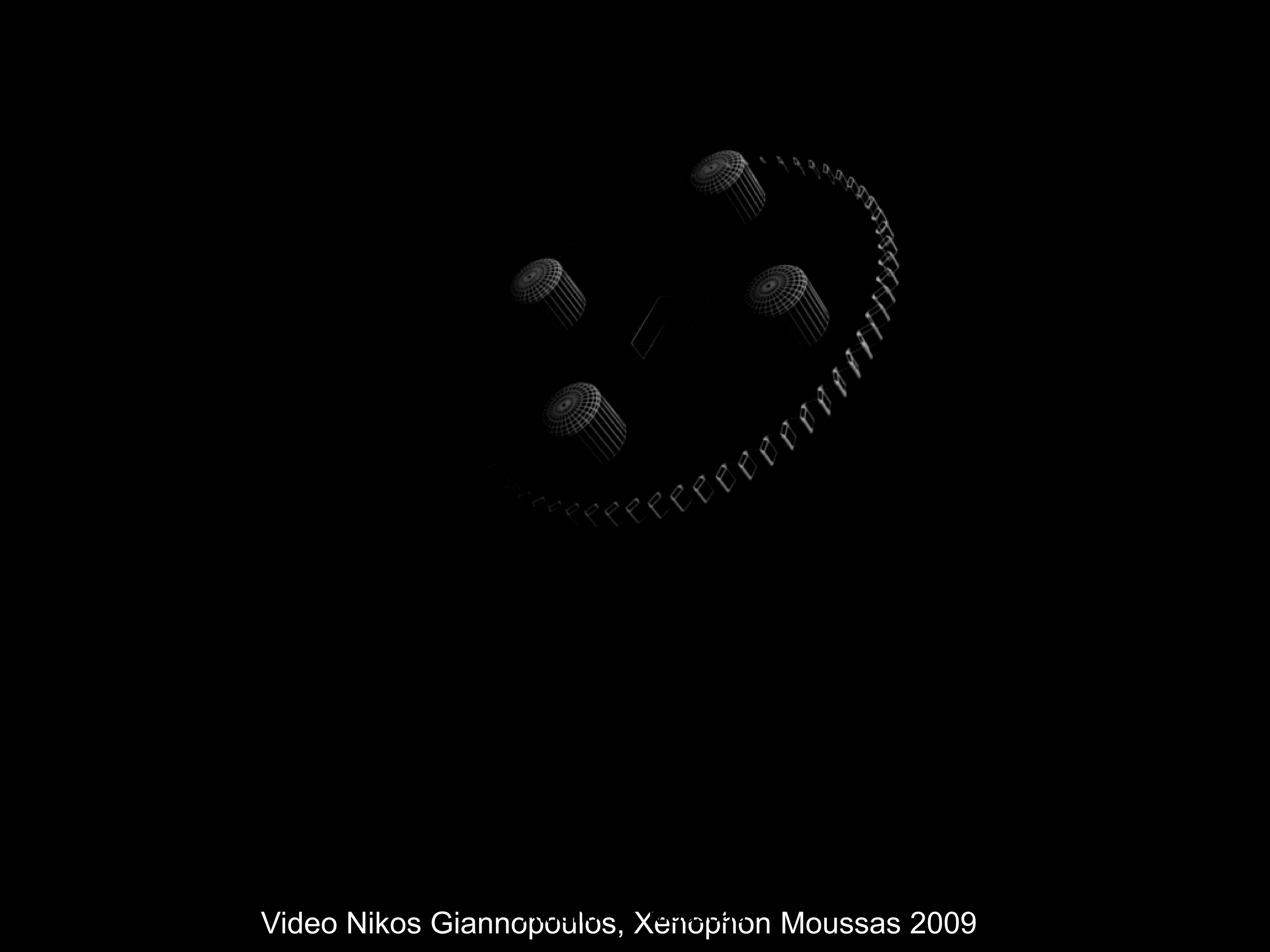

Video Nikos Giannopoulos, Xenophon Moussas 2009

Indiana Jones and *the Dial of Destiny* (2023)

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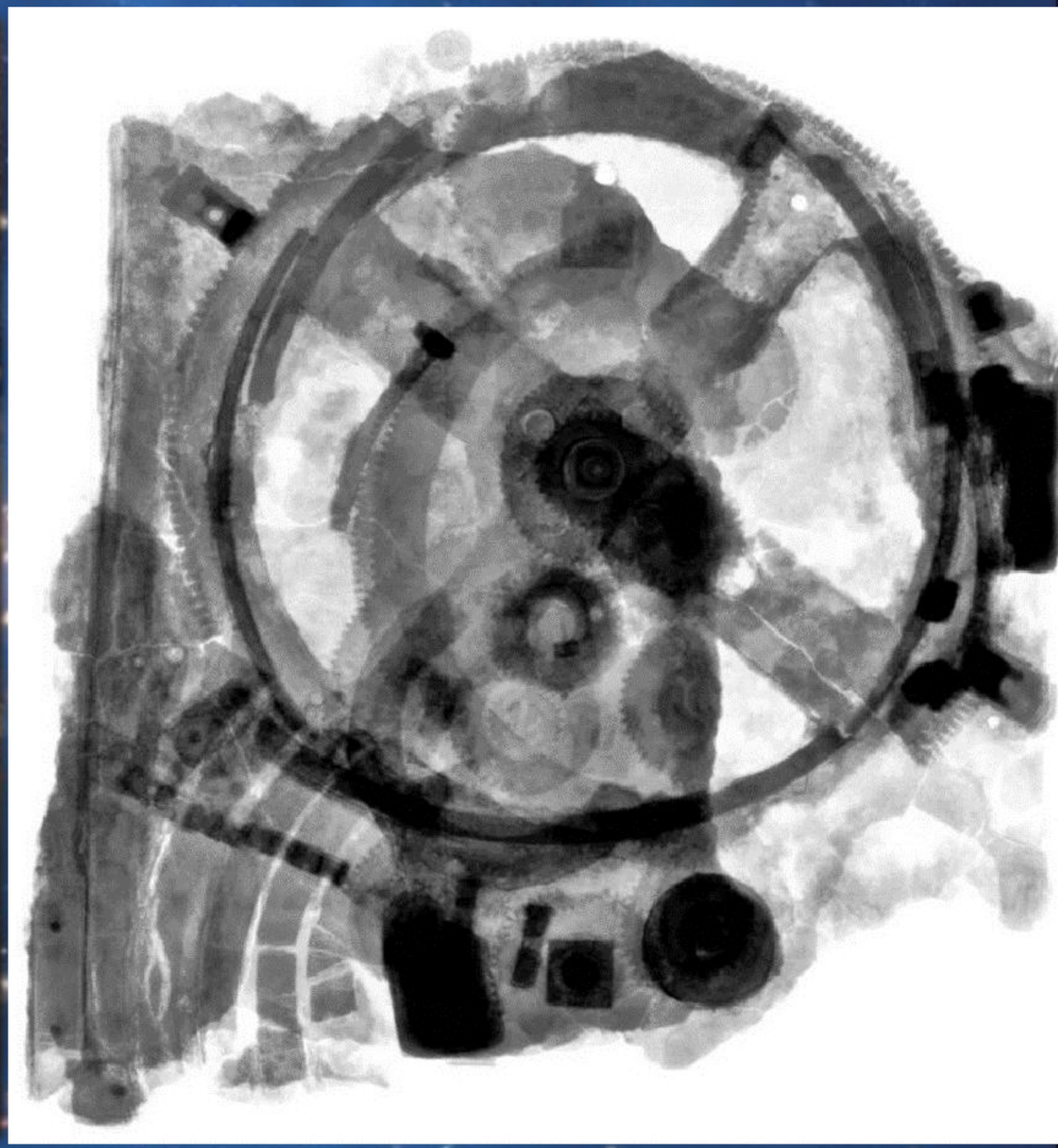

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Construcción
Construction
Κατασκευή

Universidad de Sonora
Relojes Olvera III Generacion
National and Kapodistrian University of Athens
Dr Raul Perez-Enriquez
Dr Julio Cesar Saucedo Morales
Dr Ezequiel Rodriguez Jauregui
Dr Armando Ayala
Sr Jesus Clemente Olvera Trejo
Sr Ing. Alfredo Carmona
X. Moussas

Athens, X. Moussas

The Mechanism of Antikythera works with gears that perform mathematical operations, to predict natural phenomena: position of the Sun, Moon, planets, eclipses, calendars, Olympic and other competitions.

Celestial law
Laws of physics

Νόμοι της Φυσικής

Ο Μηχανισμός των Αντικυθήρων λειτουργεί με γρανάζια που κάνουν μαθηματικές πράξεις, για να προβλέψει φυσικά φαινόμενα: θέση Ηλίου, Σελήνης, πλανητών , εκλείψεις, ημερολόγια, Ολυμπιακούς και άλλους αγώνες.

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Astronomy

The Music of the Spheres

The elements of the principles are the mathematics

Αστρονομία!

Η Μουσική των Σφαιρών

Πυθαγόρας τῶν ἀρχῶν τὰ στοιχεῖα ἀριθμοὺς καλεῖ

Pythagoras performed the first experiment
By Evi Sarantea

Pseudo-Plutarchus, Placita philosophorum (874d-911c)
Stephanus page 886, section B, line 5

Περὶ κόσμου

Πυθαγόρας πρῶτος ὠνόμασε τὴν τῶν ὅλων περιοχὴν κόσμον ἐκ τῆς ἐν αὐτῷ τάξεως

Clemens Romanus et Clementina Theol., Recognitiones [Sp.]
Book 8, chapter 15, section 1, line 1

ὅτι δὲ ἐκ πλειόνων τὸν κόσμον καὶ τὴν ὕλην συνεστάναι λέγουσιν οἱ πάντες Ἑλλήνων σοφοί, φανερόν ἐστιν· αὐτίκα γοῦν ὁ μὲν **Πυθαγόρας τῶν ἀρχῶν τὰ στοιχεῖα ἀριθμοὺς καλεῖ,** Στράτων ποιότητας, Ἀλκμαίων ἀντιθέσεις, Ἀναξίμανδρος ἄπειρον, Ἀναξαγόρας ὁμοιομερείας, Ἐπίκουρος ἀτόμους, Διόδωρος ἀμερῆ, Ἀσκληπιάδης ὄγκους, .

Image by Platonic solids info
http://www.platonicsolids.info/GIFs.htm

The harpist, 4th 3rd millennium BC performed experiments to construct the harp.
, National Archaeological Museum

All the Pythagorean principles, laws of physics, mathematics,

symmetries, simplicity, harmony, and music of the spheres,

are used to conceive, design and construct the Antikythera mechanism

Οι Πυθαγόρειες αρχές, μαθηματικά
(νόμοι της φυσικής),
απλότητα,
αρμονία,
συμμετρία
χρησιμοποιούνται για την σύλληψη, σχεδίαση και κατασκευή του μηχανισμού των Αντικυθήρων

Todos los principios pitagóricos, leyes de la física, matemáticas, simetrías, simplicidad, armonía, música de las esferas, se utilizan para concebir, diseñar y construir el mecanismo de Antikythera.

Pythagoras
Evi Sarantea

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The Cosmos is made with harmony Symmetry

in armonia con il mondo

καθ' **ἁρμονίαν τὸν κόσμον**

- Strabo, *Geography*, **Στράβων, *Γεωγραφικά***

- Καὶ διὰ τοῦτο μουσικὴν ἐκάλεσε Πλάτων καὶ ἔτι πρότερον οἱ Πυθαγόρειοι τὴν φιλοσοφίαν, καὶ καθ' **ἁρμονίαν τὸν κόσμον** συνεστάναι φασί, πᾶν τὸ μουσικὸν εἶδος θεῶν ἔργον ὑπολαμβάνοντε

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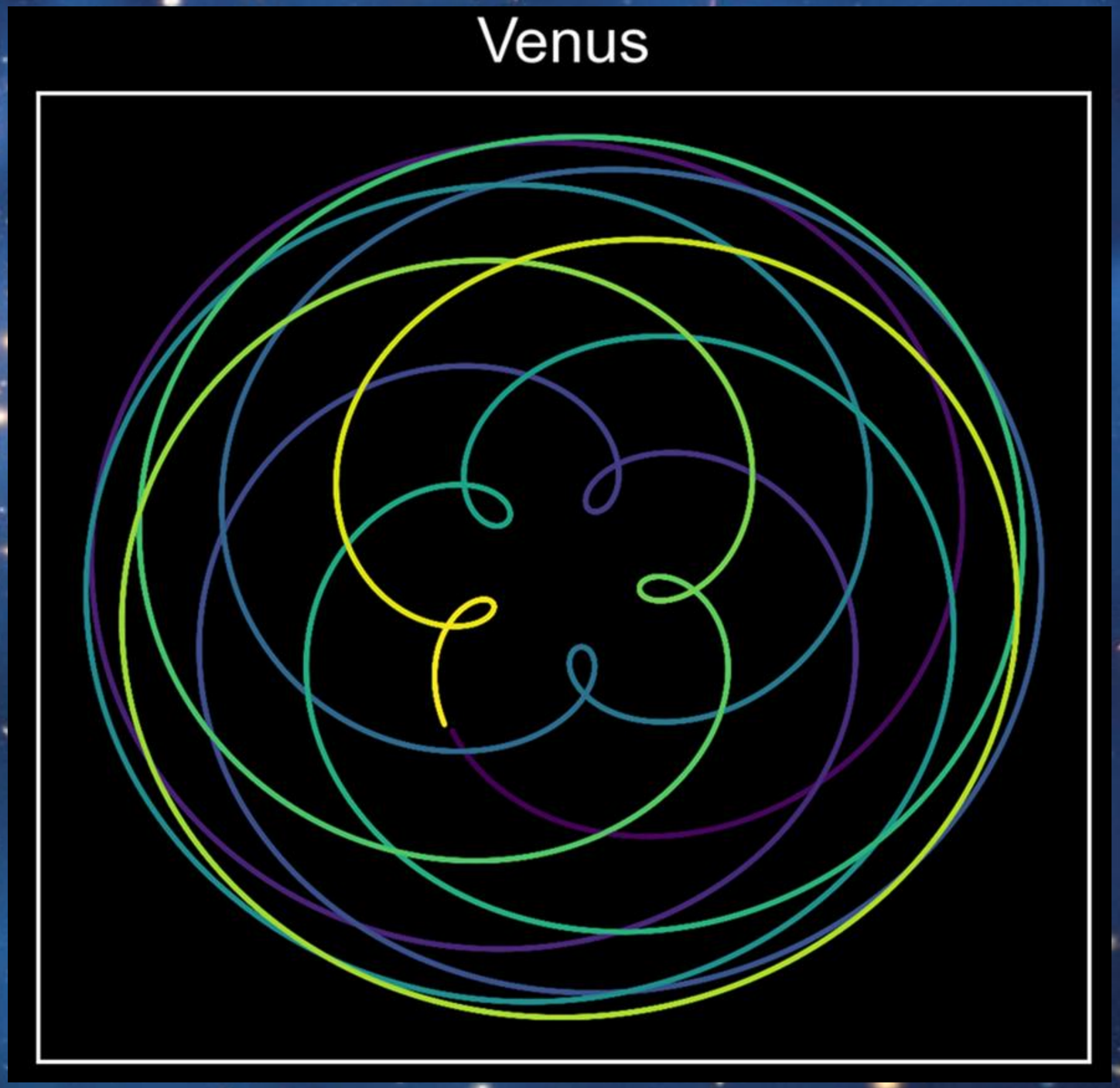
ciclo di otto anni, otto anni, usato dagli ateniesi prima degli anni di Metone, per riconciliare gli anni lunari e solari, intervallando tre mesi per completare un ciclo di 2922 giorni (= otto anni = 5 periodi sinodici di Venere di 584 giorni [approssimativamente] = 99 mesi [29,5 giorni]), Plut. 2. 892

ὀκταετηρίς, κύκλος ὀκτὼ ἐτῶν, ἐν χρήσει παρ' Ἀθηναίοις πρὸ τῶν χρόνων τοῦ Μέτωνος πρὸς συμβιβασμὸν τοῦ σεληνιακοῦ καὶ τοῦ ἡλιακοῦ ἔτους, παρεμβαλλομένων τριῶν μηνῶν εἰς συμπλήρωσιν κύκλου ἡμερῶν 2922 (= οκτώ έτη = 5 συνοδικές περίοδοι Αφροδίτης των 584 ημερών [περίπου] = 99 μήνες [29,5 ημερών]), Πλούτ. 2. 892B.

due Olimpiadi seguono esattamente il calendario degli Ottatiri. In ciascuno Ottatiri sono definite due Olimpiadi. La prima Olimpiade quadriennale dura 49 mesi lunari e i successivi 50 mesi sinodici lunari. L'Olimpiade si basa sull'ottatiris, è mezza ottatiris. L'Ottateris si basa sulla coordinazione dei movimenti del Sole, di due pianeti, della Terra, di Venere e della Luna. Questi corpi celesti danzano in concerto una danza ben pianificata di grande precisione, un kalamatian cosmico, un ballo. Fin dai tempi preistorici, si osserva che otto anni sono 99 mesi e 5 congiunzioni di Venere.



2922 giorni (= otto anni = 5 periodi sinodici di Venere di 584 giorni [approssimativamente] = 99 mesi [29,5 giorni]), Plut. 2. 892 .

Ο Κόσμος, το Σύμπαν είναι φτιαγμένο με αρμονία
Harmony, the *music of the spheres* in the Antikythera mechanism

- Ο μηχανισμός περιέχει όλη την αρμονία του Σύμπαντος.
- The designer of the Anntikythera mechanism, of this mechanical Cosmos, includes all the *Music of the spheres*, the resonances of the solar system in the mathematics, the gears and the manual of this ancient planetarium.

- Il progettista del meccanismo di Anntikythera, di questo cosmo meccanico, include tutta la musica delle sfere,
- le risonanze del sistema solare
- nella matematica, gli ingranaggi e il manuale di questo antico planetario.

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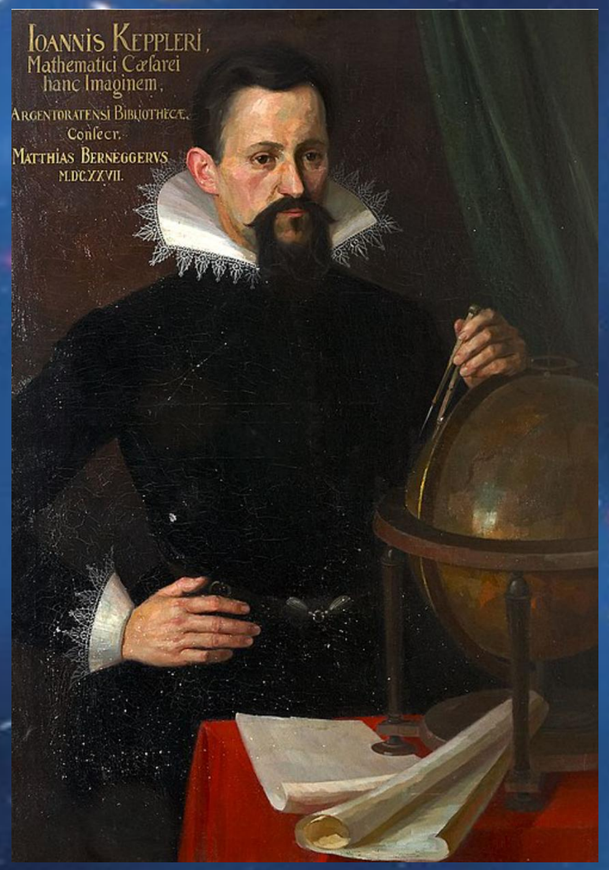
I quattro ingranaggi che danno la velocità variabile della Luna attorno alla Terra, secondo la seconda legge di Keplero

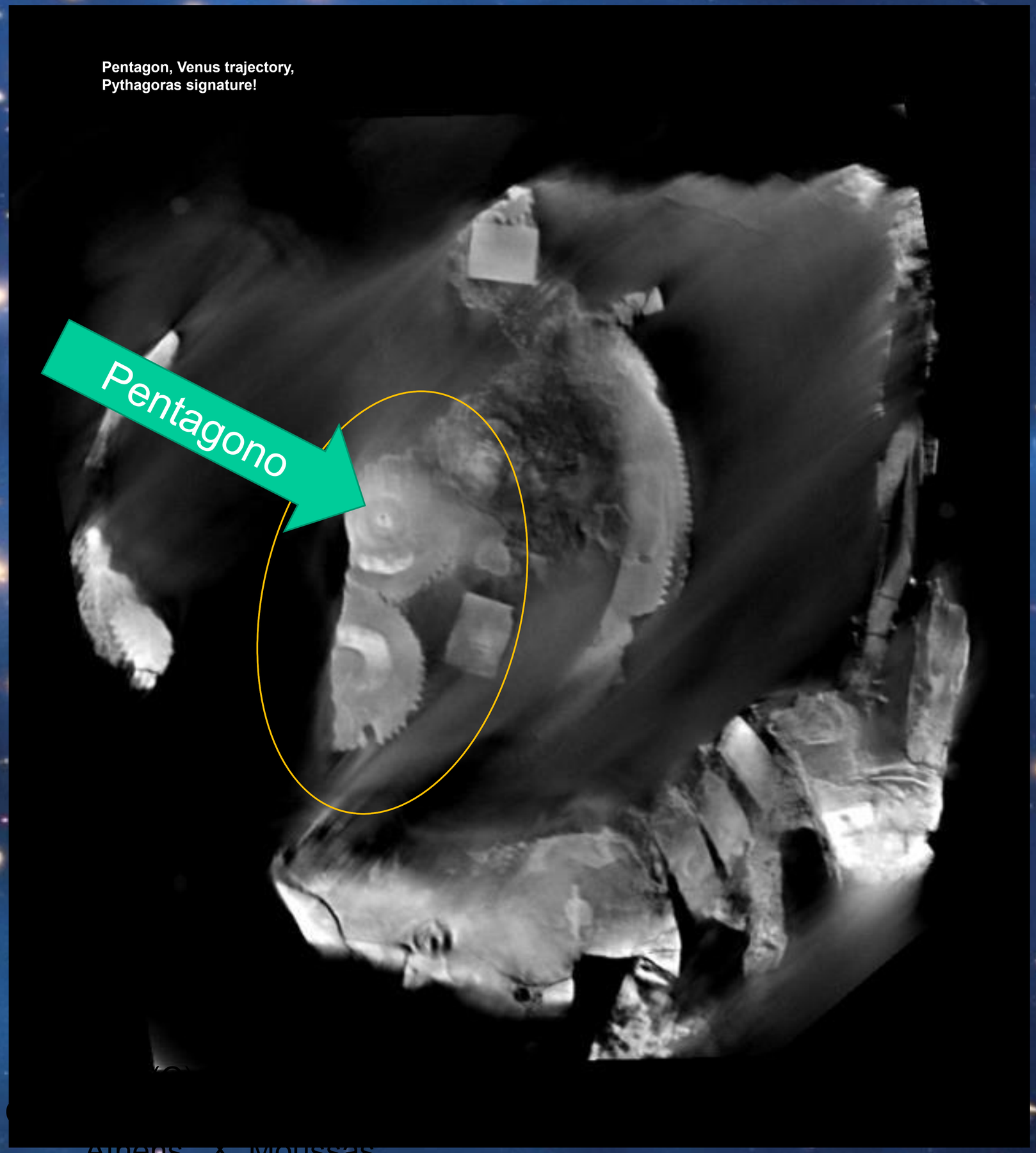
The four gears that give the Moon's variable speed around the Earth, according to Kepler's 2nd law

$$R(t) = R[\sin(\omega t) + i\cos(\omega t)] + r_1[\sin(\omega t) + i\, r_2\cos(\omega t)]$$

Τα τέσσερα γρανάζια που δίνουν τη μεταβλητή ταχύτητα της Σελήνης γύρω από τη Γη, σύμφωνα με τον 2ο νόμο του Κέπλερ.



Portrait of Johannes Kepler. By August Köhler-
Kepler-Museum in Weil der Stadt



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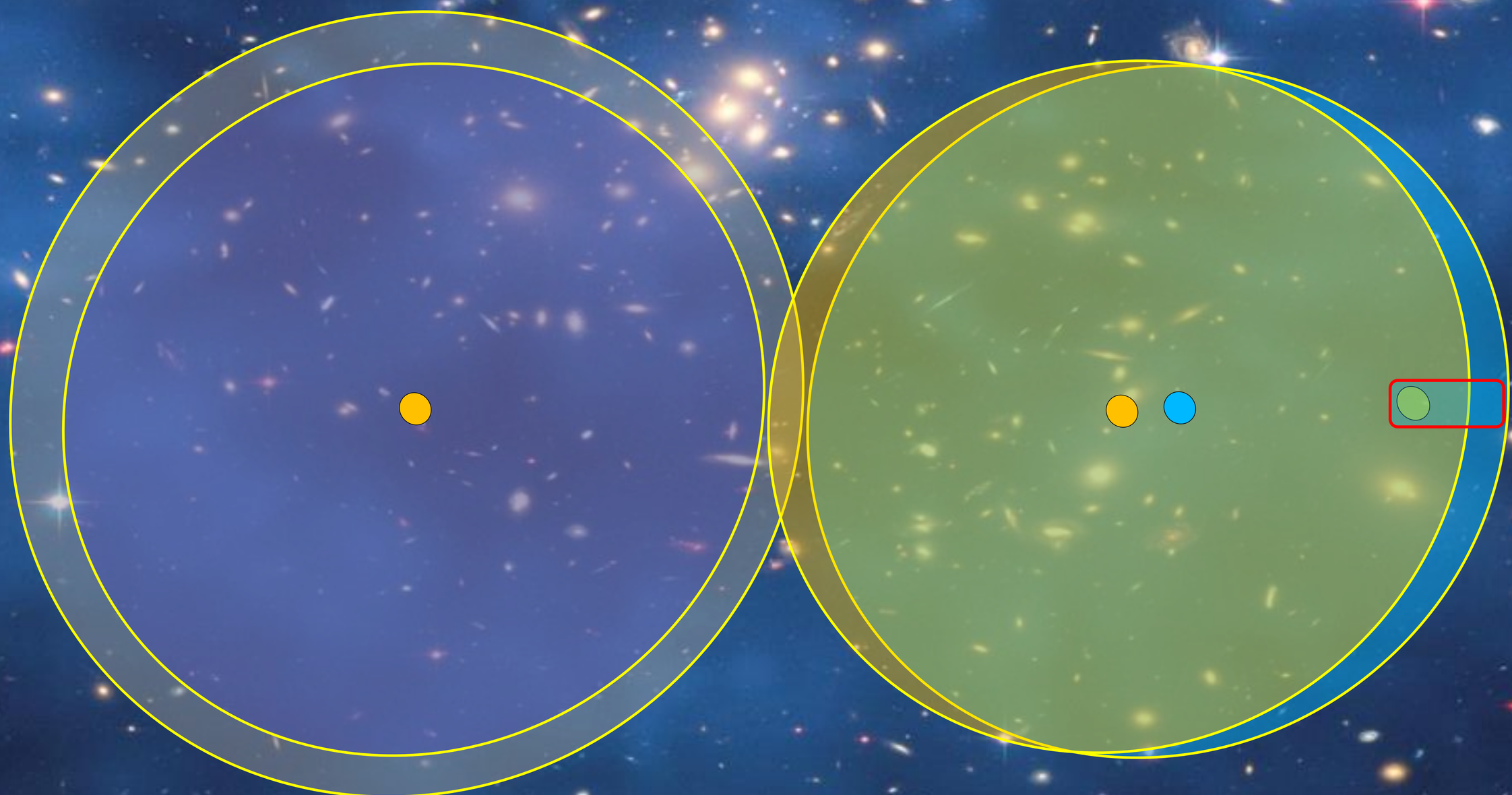
Le quattro marce che danno la velocità variabile della Luna attorno alla Terra, secondo la seconda legge di Keplero: veloci al perigeo, lenti all'apogeo

The four gears that give the Moon's variable speed around the Earth, according to Kepler's 2nd law: fast at perigee, slow at apogee

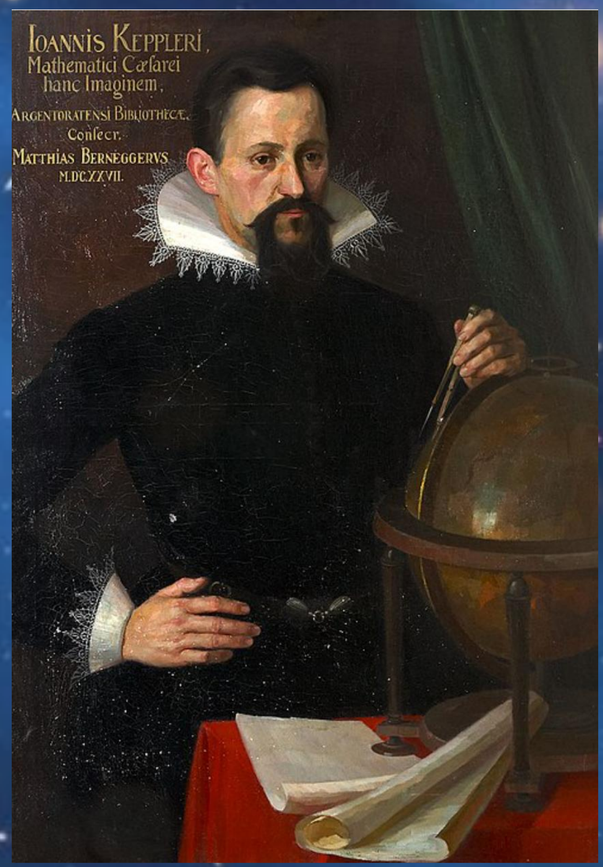
$$R(t) = R[\sin(\omega t) + i \cos(\omega t)] + r_1[\sin(\omega t) + i\, r_2 \cos(\omega t)]$$



«Firma» dei pitagorici. Pentagono Sistema a ruota epiciclica con spillo e fessura

Υπογραφή Πυθαγορείων.
Πεντάγωνο
[Επικυκλικό σύστημα τροχών
με πίρο και σχισμή

Signature of Pyhtagoreans [the pentagon]
Epicyclic
Pin-and-Slot Lunar Mechanism



Portrait of Johannes Kepler. By August Köhler-
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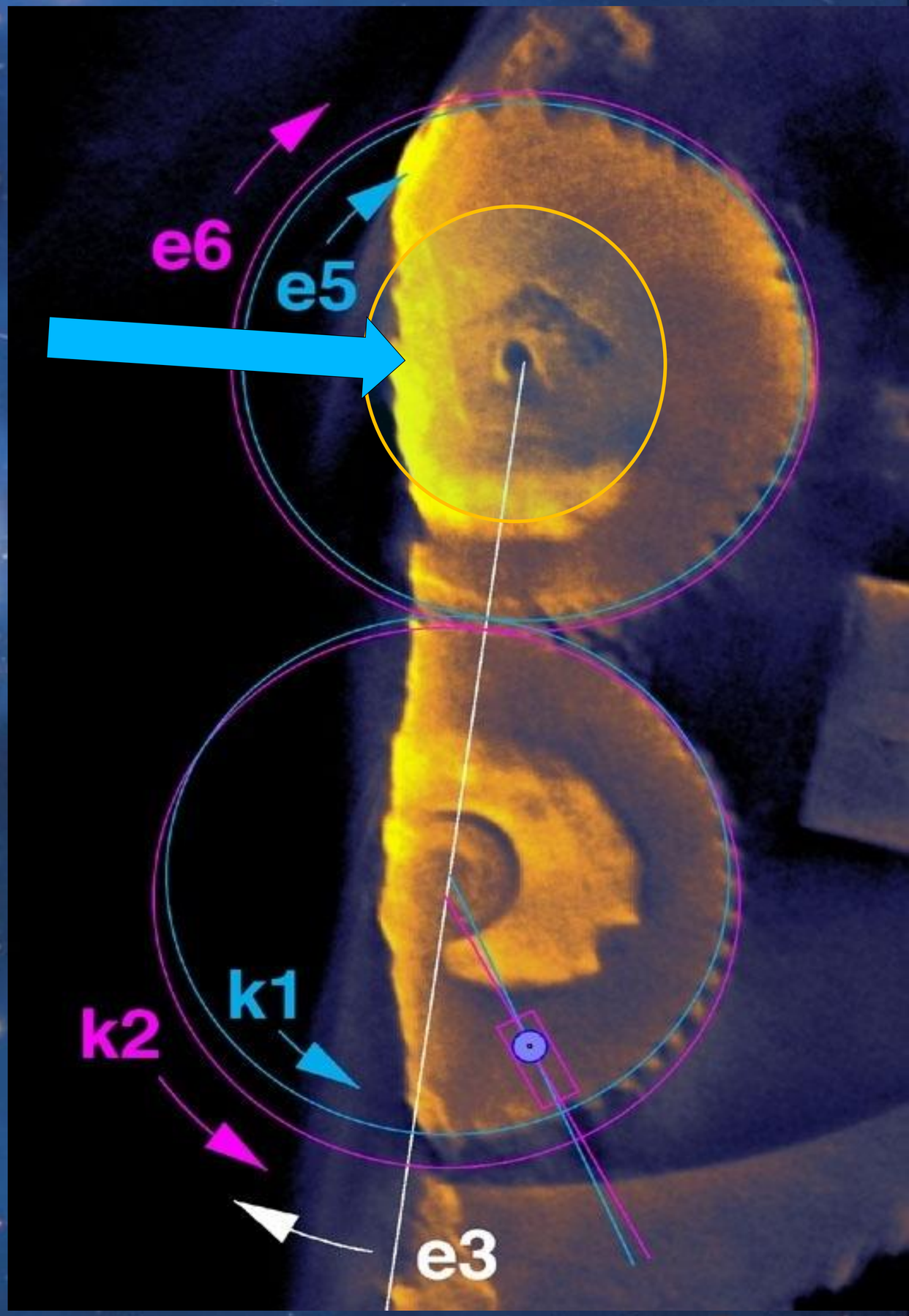

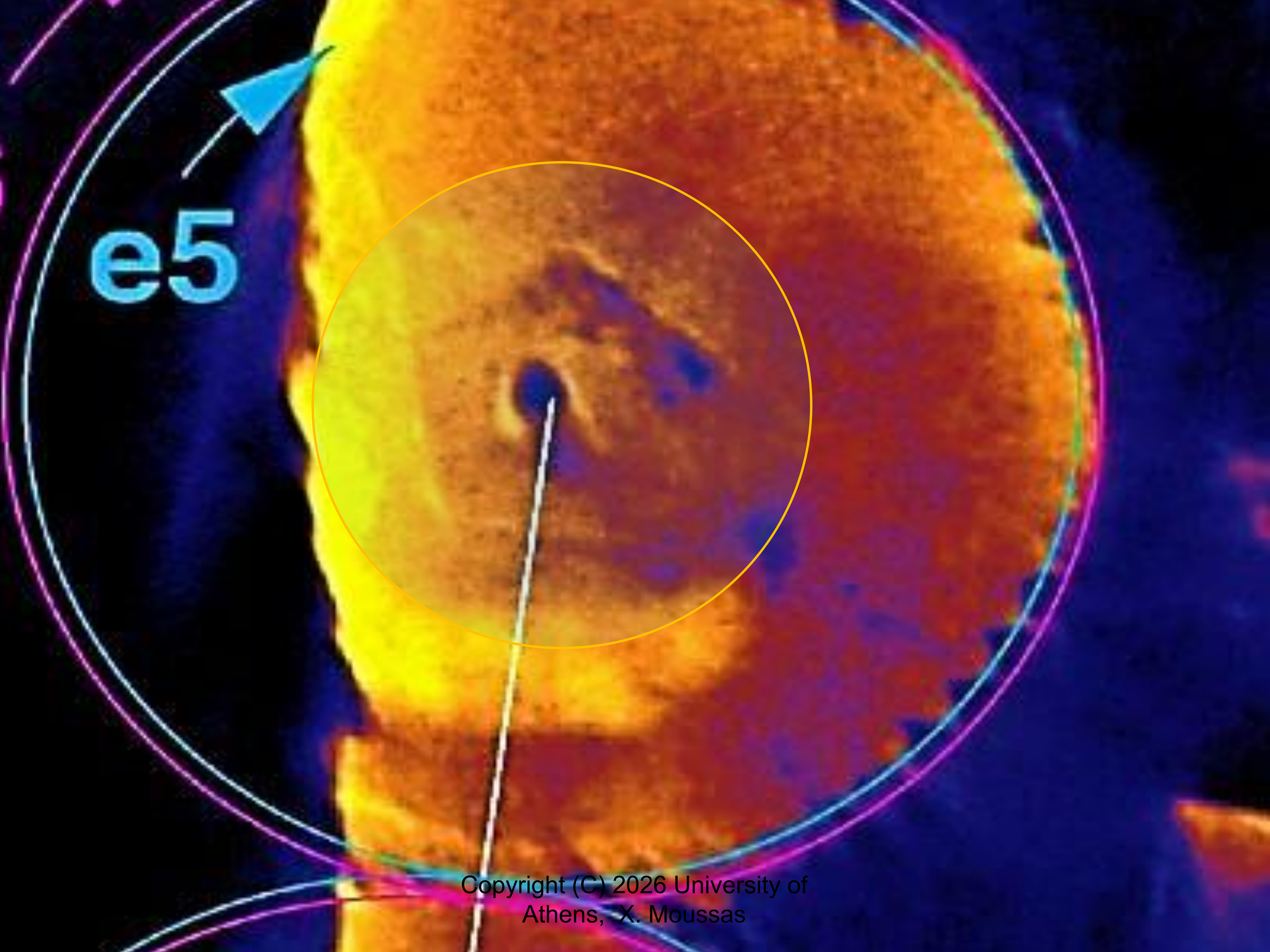

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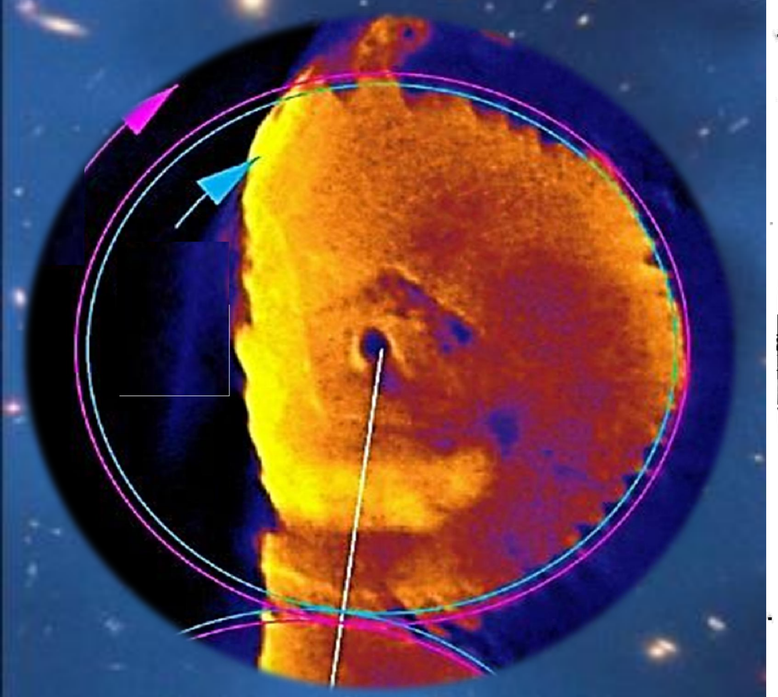
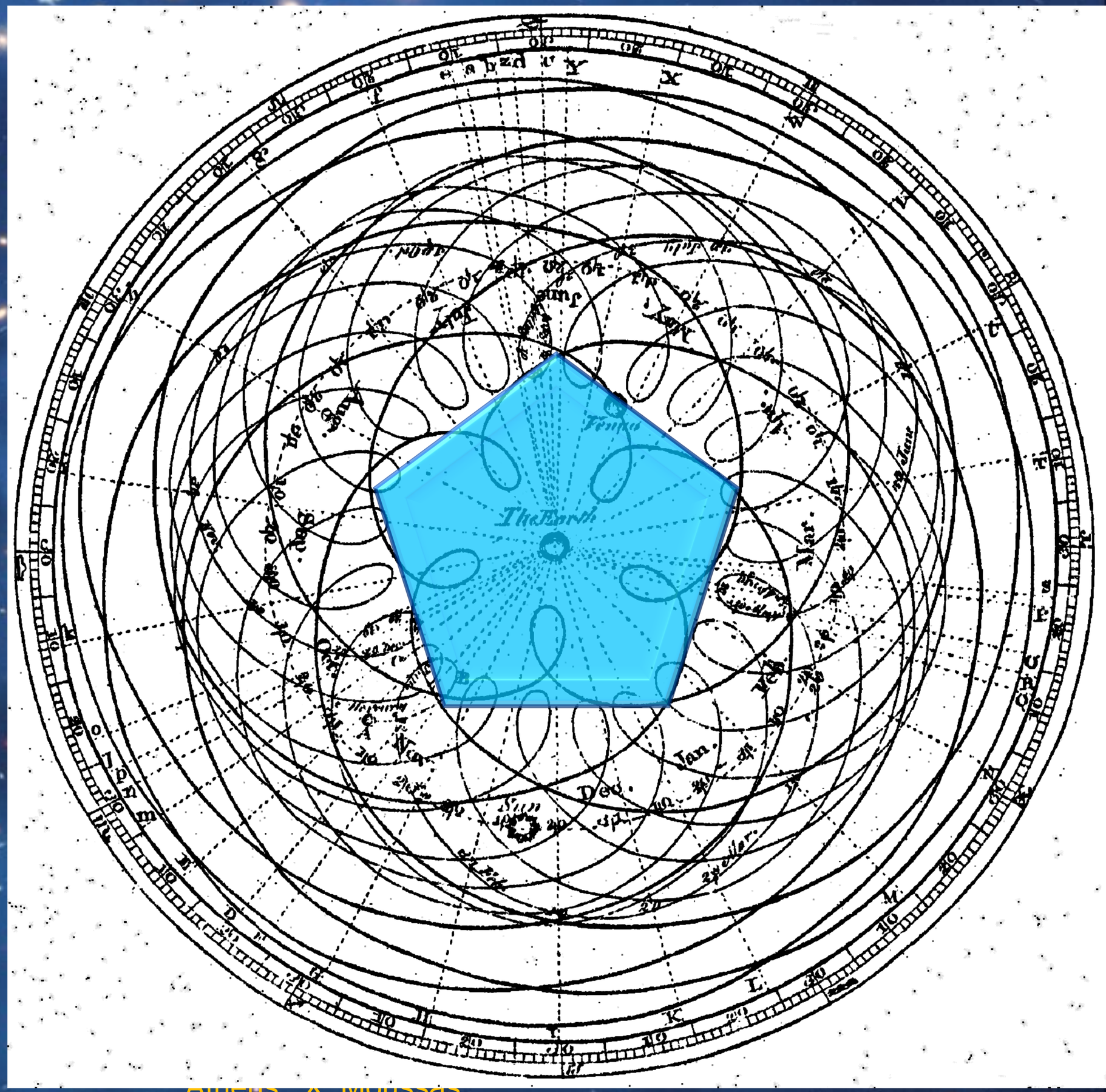
The motion of the planets, epicycles.



The orbit of Venus is like a pentagon. The Pythagoreans used the pentagon as their symbol. We have discovered a pentagon inside the mechanism, hidden between two gears that give variable speed to the Moon, following Kepler's second law to a good approximation.



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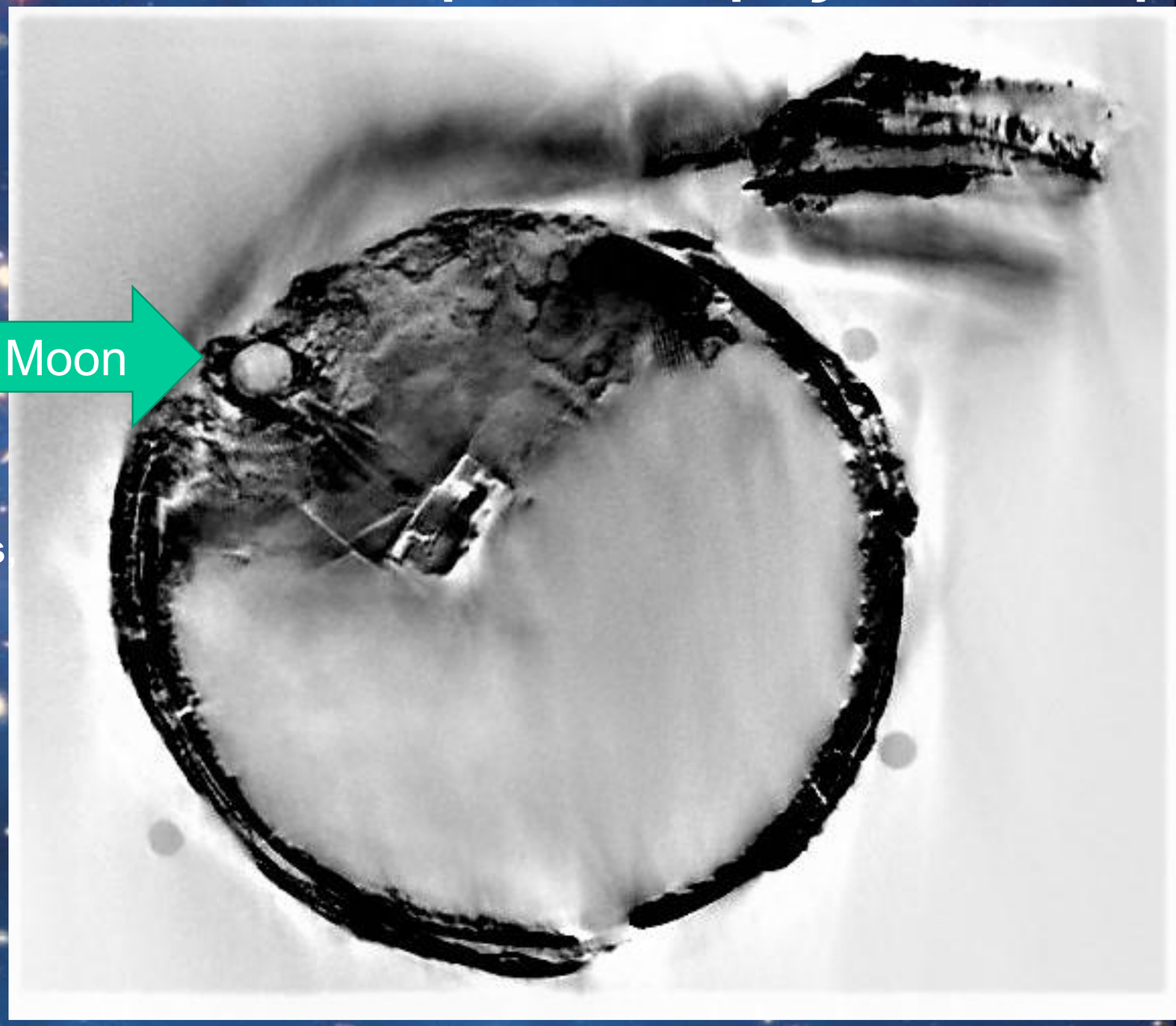
2nd law of Kepler 2ος νόμος του Κέπλερ



It is an astronomical computer. predicts the positions of the Sun and the Moon, the phases of the Moon.
It **predicts the lunar and solar eclipses year, month, day, time**.
Surprisingly, it determines the position of the Moon, which is calculated using **a substitute for Kepler's 2nd law**.
Specifically, the Moon indicator in the mechanism has **a realistic variable speed**. The speed is maximum at the periphery and minimum at the apogee.

Είναι ένας **αστρονομικός υπολογιστής.**
Θα μπορούσε:

- να προβλέψει τις θέσεις του Ήλιου και της Σελήνης, τις φάσεις της Σελήνης.
- να προβλέψει τις εκλείψεις Σελήνης και Ηλίου, έτος, μήνα, ημέρα, ώρα.

Παραδόξως, προσδιορίζει τη θέση της Σελήνης η οποία υπολογίζεται χρησιμοποιώντας ένα υποκατάστατο του **2ου νόμου του Κέπλερ**.
Συγκεκριμένα ο δείκτης της Σελήνης στον μηχανισμό έχει ρεαλιστική μεταβλητή ταχύτητα. Η ταχύτητα είναι μέγιστη στο περίγειο και ελάχιστη στο απόγειο.

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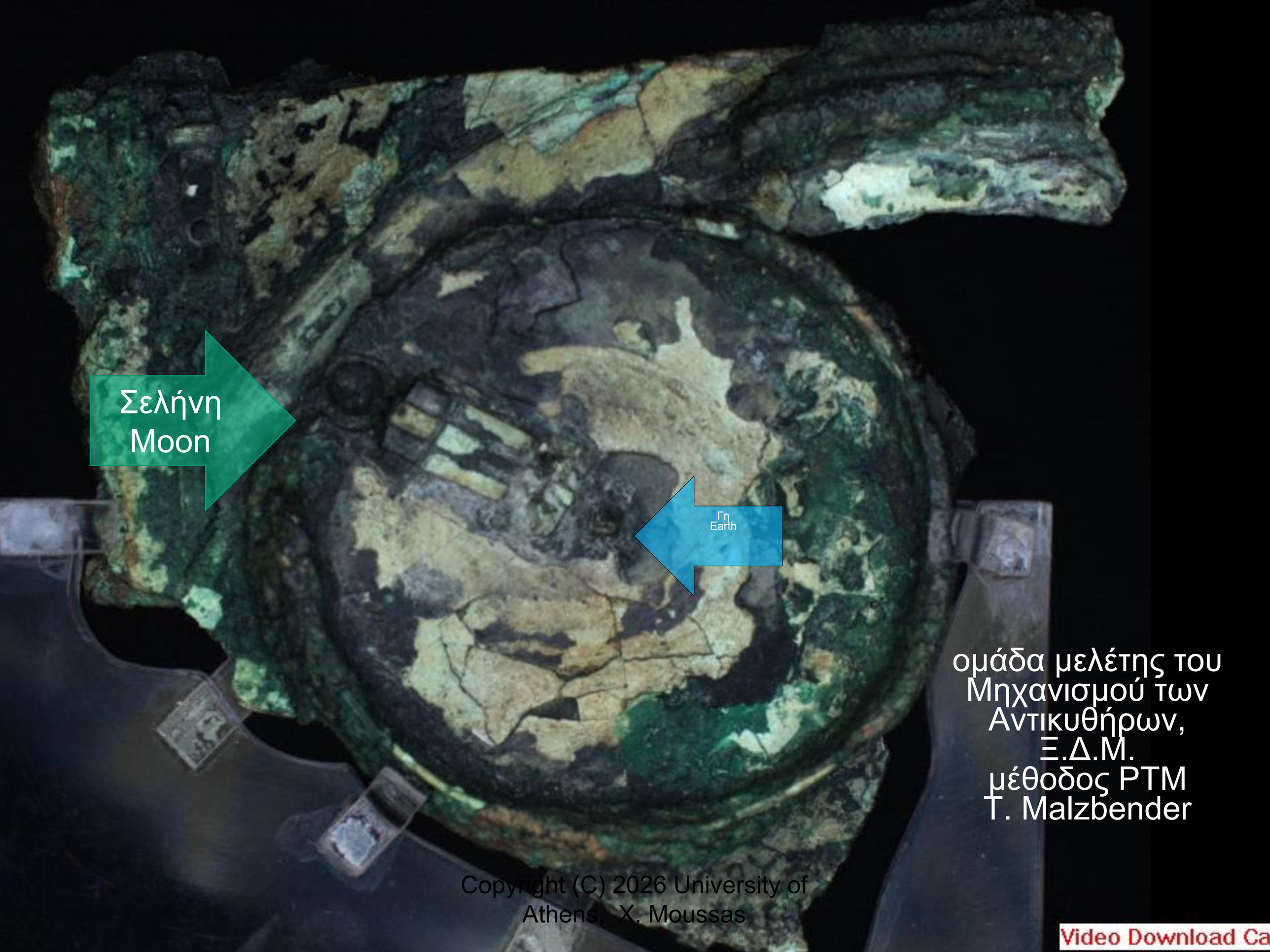

ομάδα μελέτης του Μηχανισμού των Αντικυθήρων, Ξ.Δ.Μ.
μέθοδος PTM
T. Malzbender

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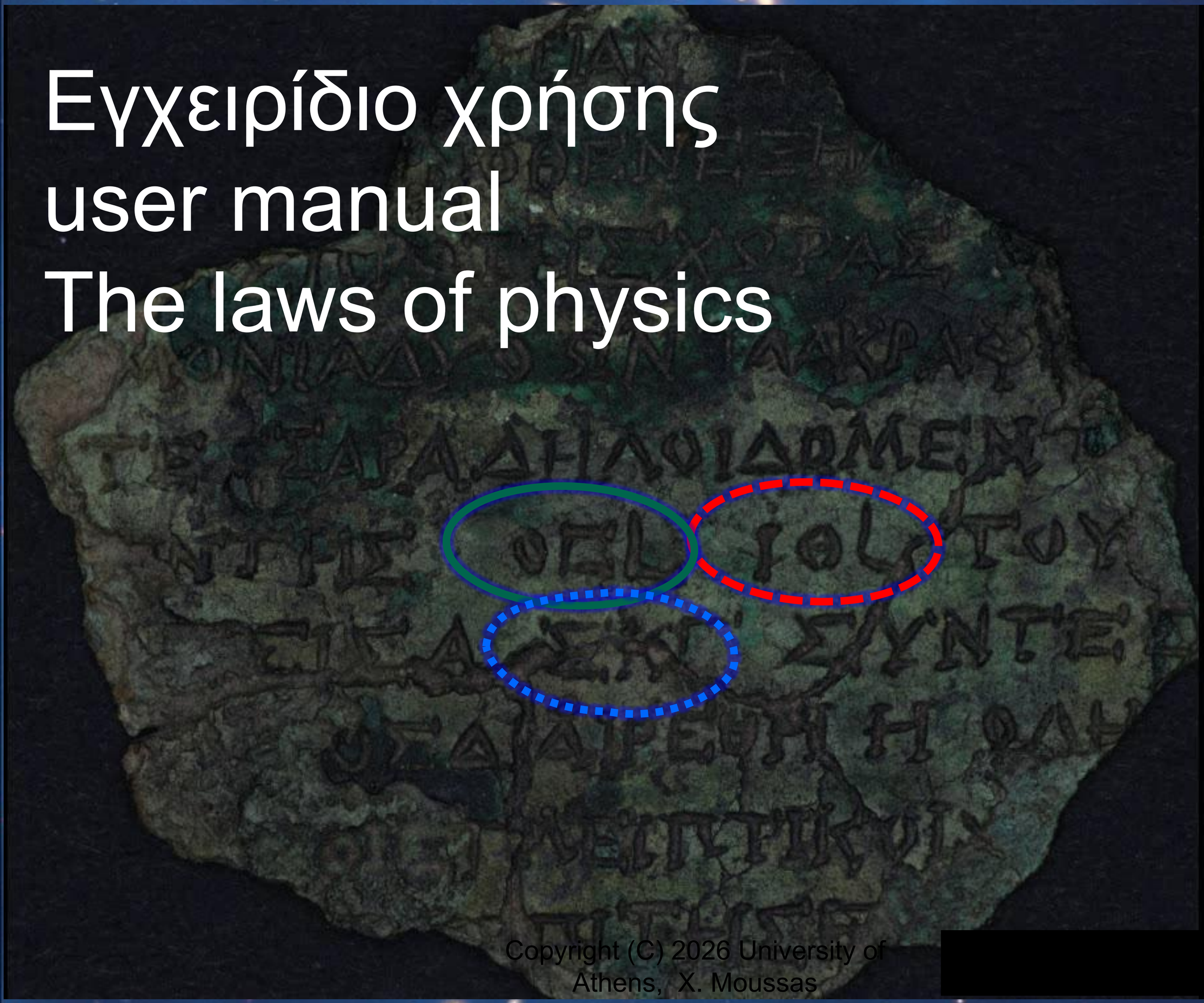
Video Download Ca

Εγχειρίδιο χρήσης
user manual
The laws of physics



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Light 1

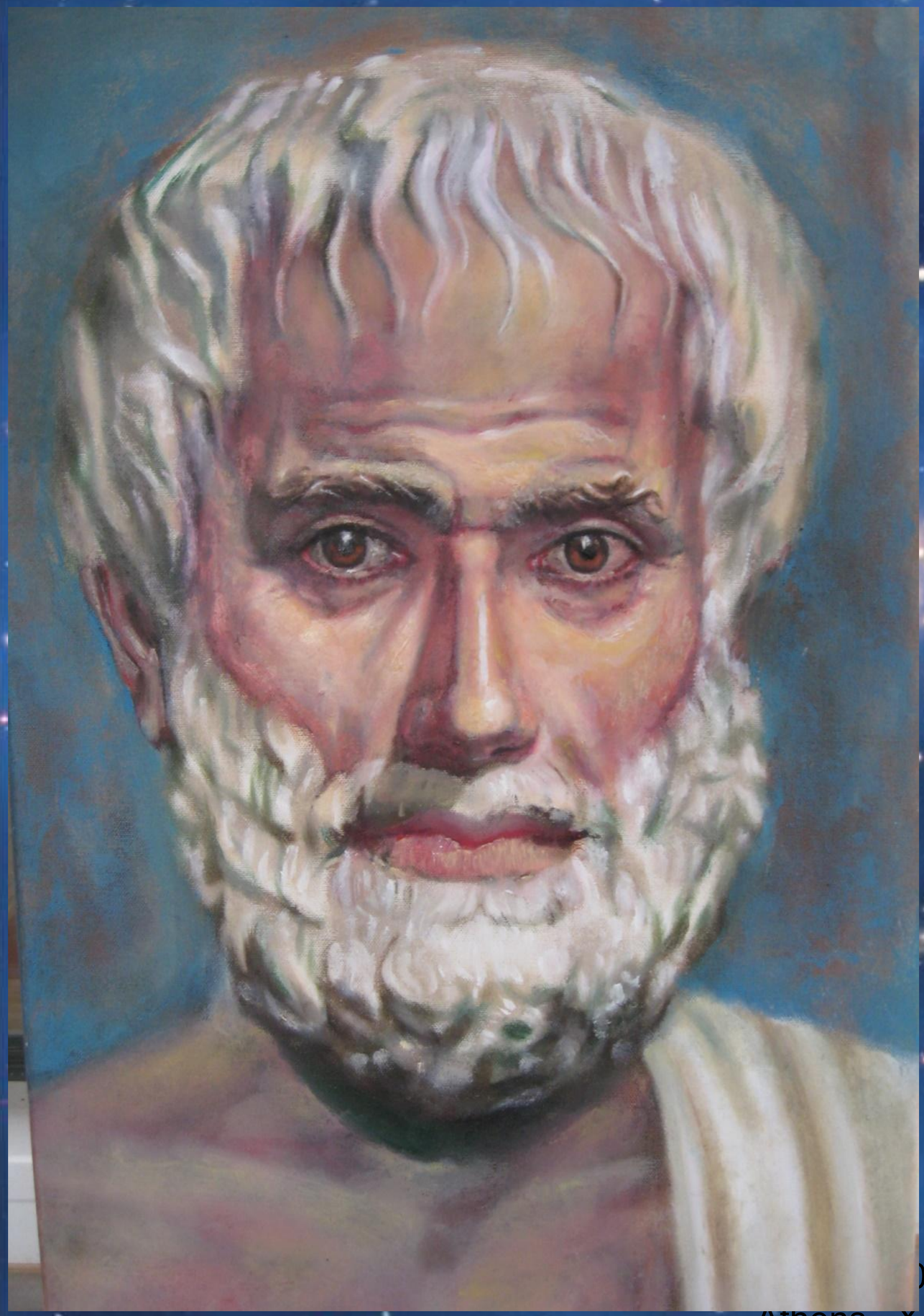
ΕΛΙΚΡΙΤΜΗΜΑΤΑ ΣΑΣ

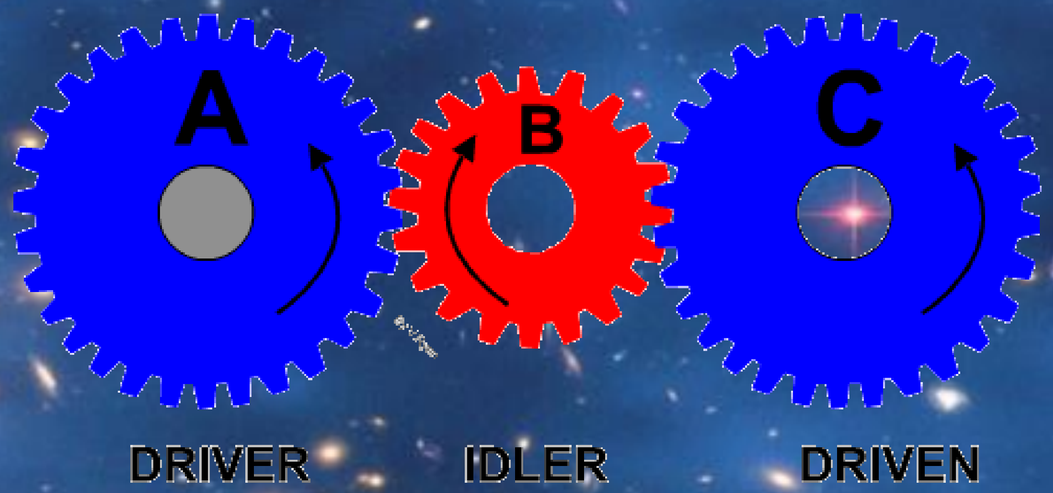
ΔΙΑΝΟΜΑΙ

ΝΤΡΑΔΡΙ

ΤΙ

ΡΗΤ





Αριστοτέλης
Εύη Σαραντέα
Aristotle
Evi Sarantea

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Έναρξη Ολυμπιακών Αγώνων
Opening of the Olympic Games

Πλανητικοί συντονισμοί:
Στο εγχειρίδιο χρήσης ή / και στο πρόγραμμα που γράφτηκε με τα γρανάζια διαβάζουμε διάφορες αντηχήσεις ουράνιων σωμάτων.
Οκτάετηρης (8ετής συντονισμός Ήλιου, Γης, Αφροδίτης και Σελήνης.
Ο 19ετής Μετωνικός κύκλος και ο 76ετής Καλιπικός κύκλος, δηλαδή οι περιοδικότητες των Σεληνιακών φάσεων, συντονισμός Γης, Σελήνης, Ήλιου.
Υπολογίζονται οι κύκλοι Σάρος (223 μήνες) και Exeligmos (669 μήνες) (περιοδικότητες εκλείψεων, συντονισμός Γης, Σελήνης, Ήλιου) και ο μηχανισμός δίνει το αποτέλεσμα σε κατάλληλες κλίμακες.
Δύο ακόμη συντονισμοί πολύ μεγάλης περιόδου αναφέρονται στο εγχειρίδιο: 462 χρόνια για την Αφροδίτη και
442 χρόνια για τον Κρόνο.
Η περίοδος των 462 ετών είναι 289 συνοδικές περίοδοι της Αφροδίτης, 216 του Άρη και 423 του Δία. Η περίοδος 442 y ισούται με 427 συνοδική του Κρόνου, 207 του Άρη και 1368 του Ερμή.

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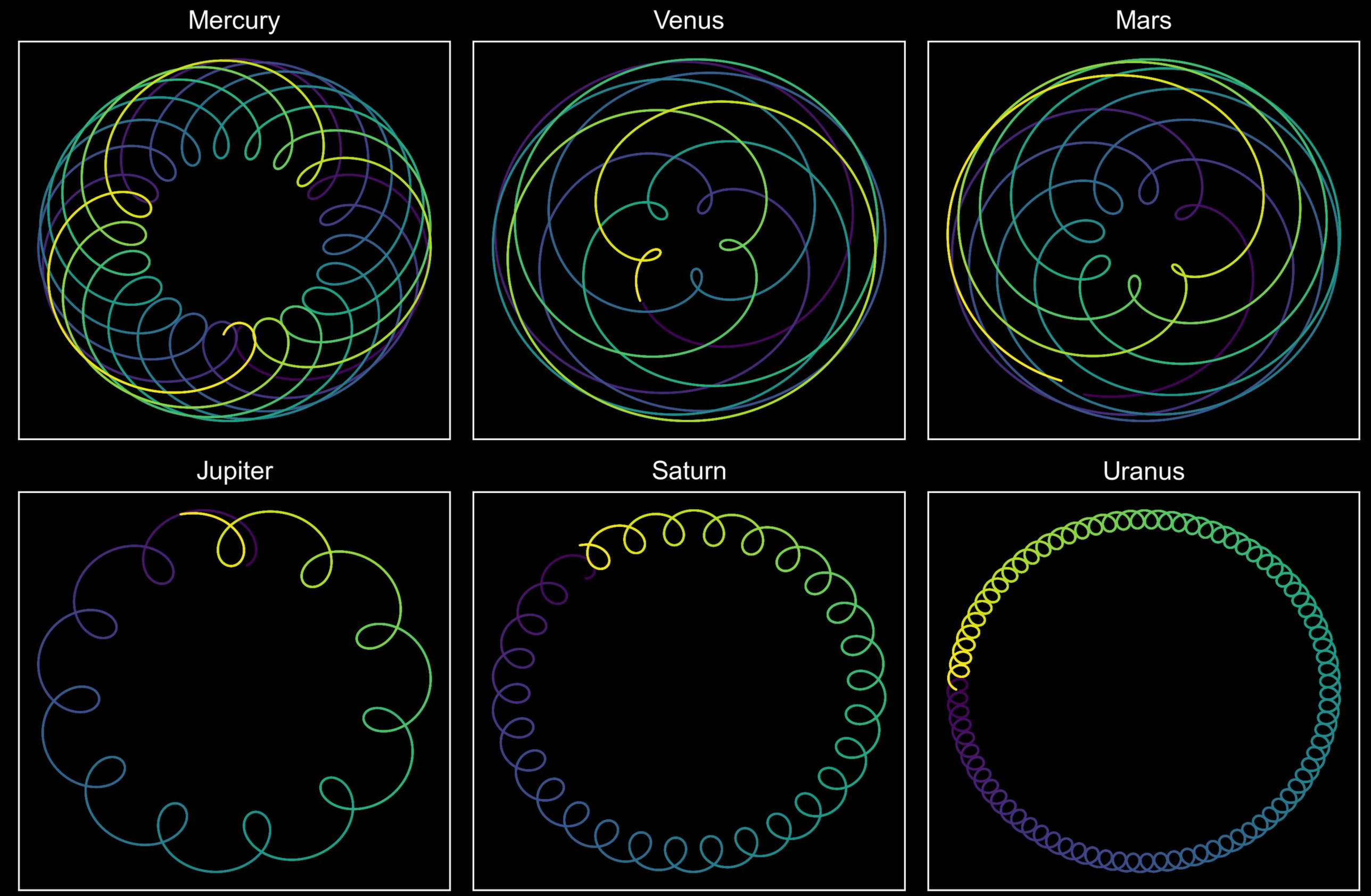
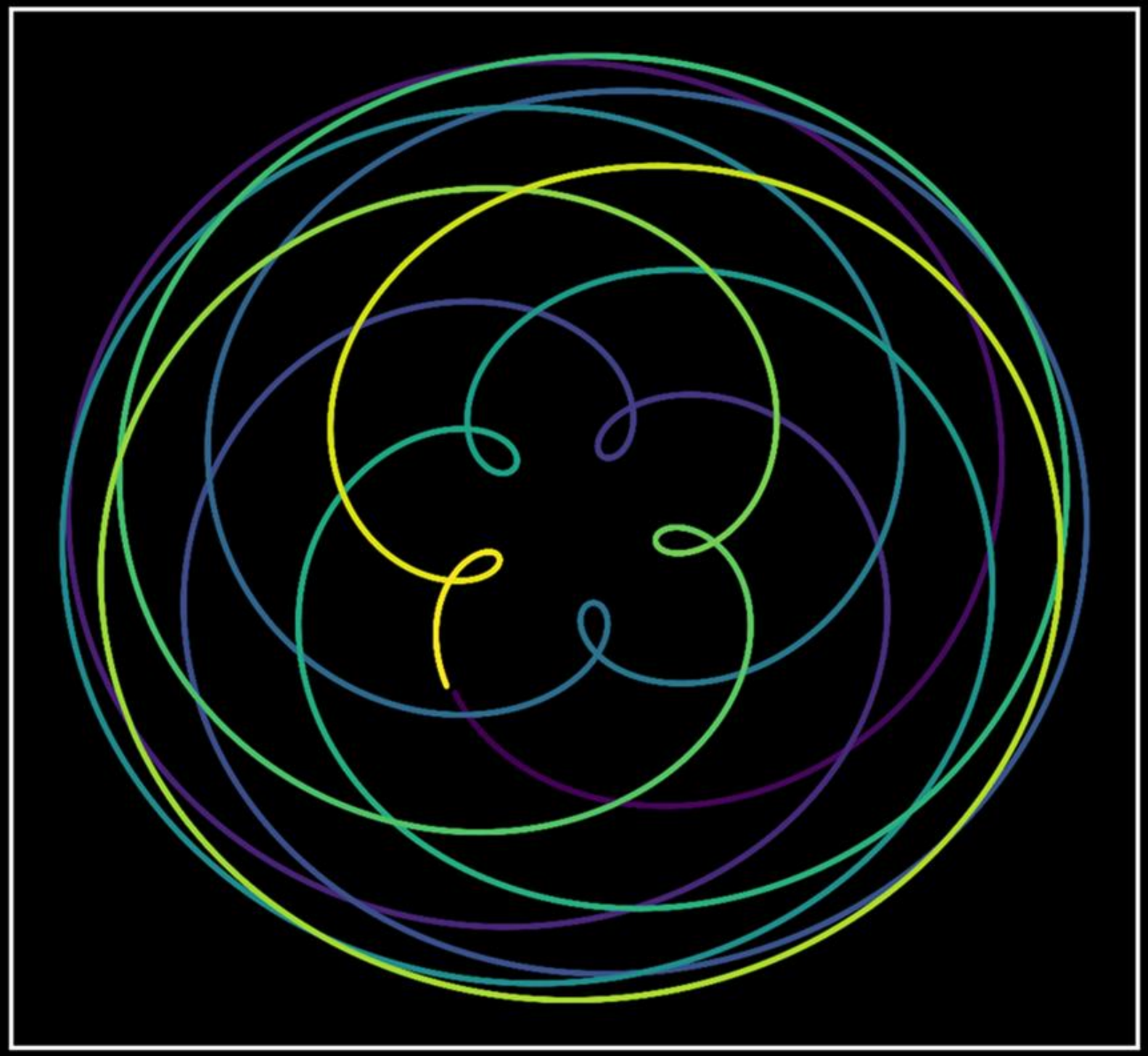


https://www.reddit.com/r/Astronomy/comments/s99umt/motion_of_solar_system_planets_relative_to_earth/#lightbox

Venus



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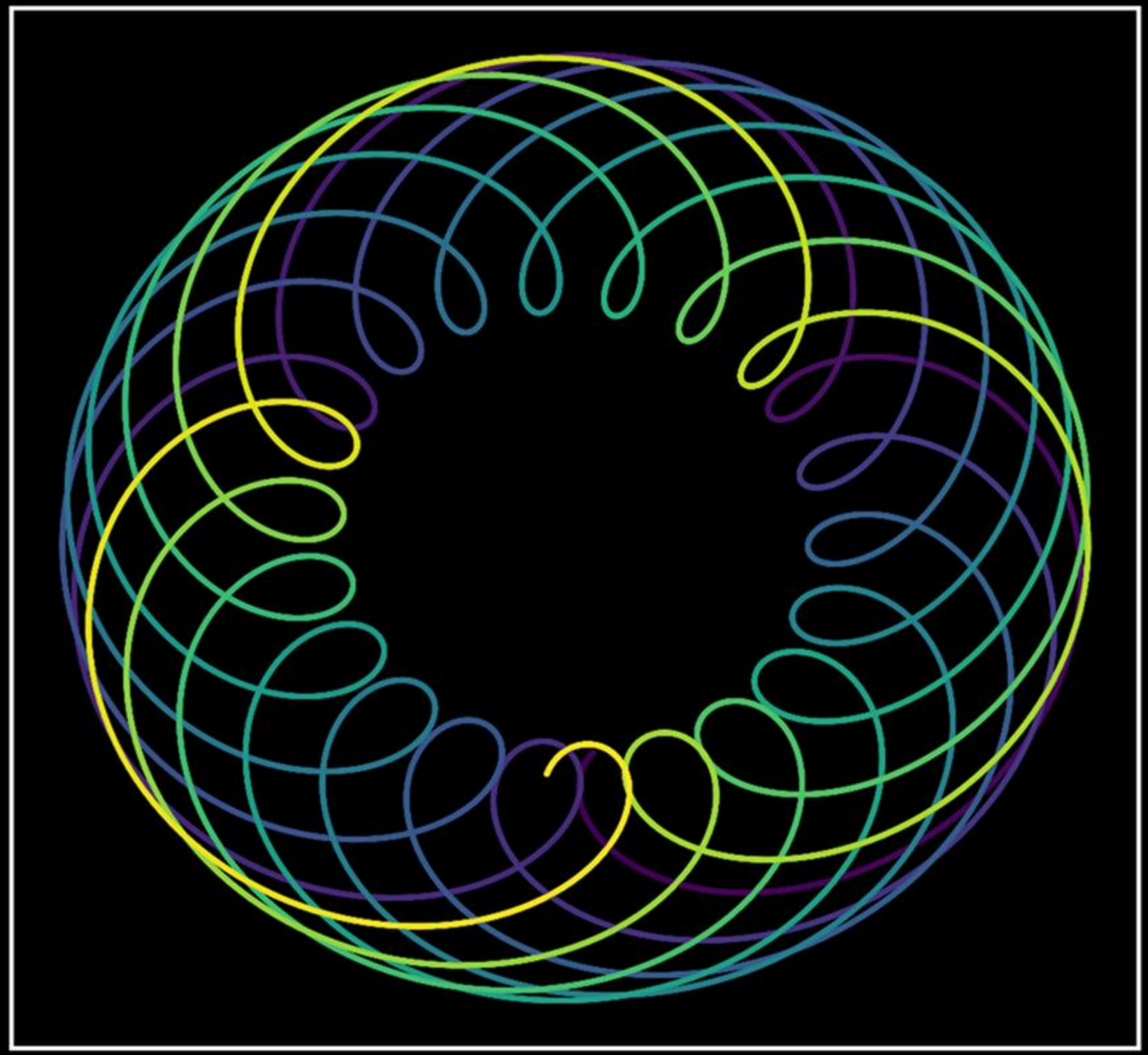
Mercury



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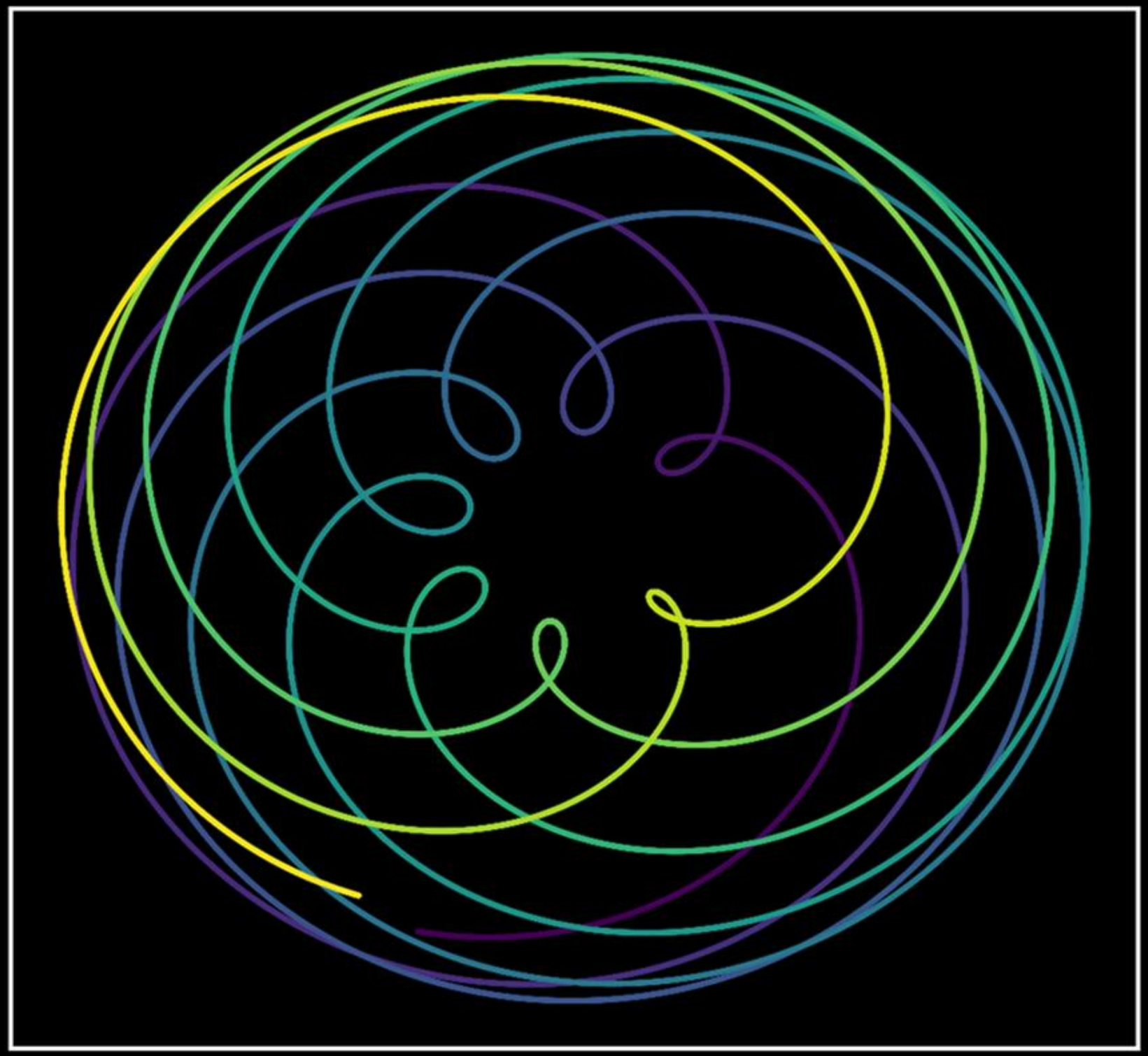
Mars



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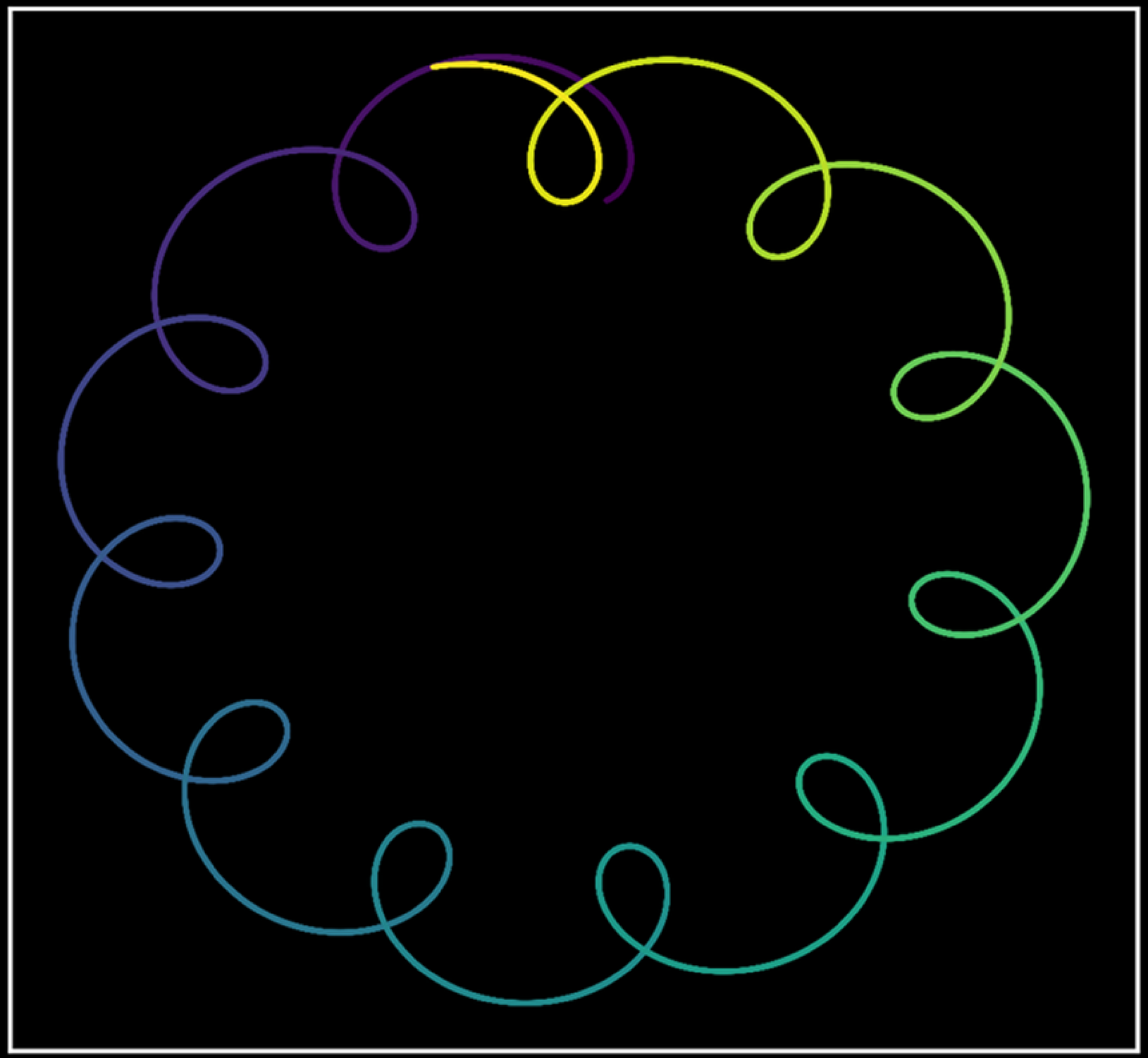
Jupiter



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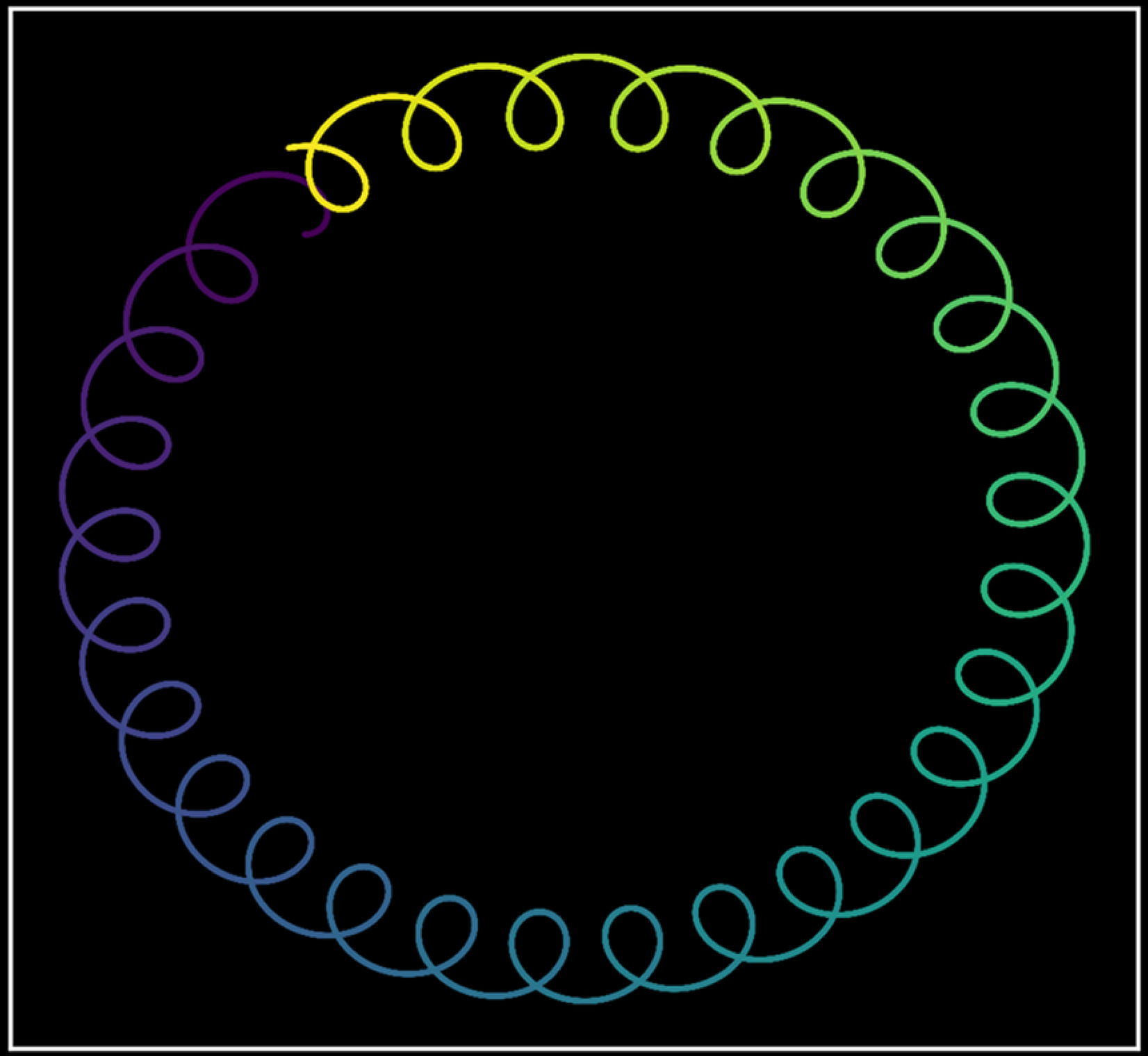
Saturn



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Cosmic(?) Greek dance [five planets?]
c 1900 to 1700 BC
Athanasia Kanta *Minoan Crete and the Origins of Ancient Greek Theatre*
Ed. Itanos 2013

Danza ¿cósmica? griega [¿cinco planetas?]

Danza secolare greca? I cinque pianeti?

Ελληνικός Κοσμικός χορός; Οι πέντε πλανήτες;

Agia Triada.1900-1700 B.C.

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Μένανδρος, *Περὶ ἐπιδεικτικῶν*

οἱ μὲν σὲ Λύκειον λέγουσιν, οἱ δὲ Δήλιον, οἱ δὲ Ἀσκραῖον, ἄλλοι δὲ Ἄκτιον, Λακεδαιμόνιοι δὲ Ἀμυκλαῖον, Ἀθηναῖοι πατρῷον, Βραγχιάτην Μιλήσιοι· πᾶσαν πόλιν καὶ πᾶσαν χώραν καὶ πᾶν ἔθνος διέπεις καὶ καθάπερ τὸν οὐρανὸν περιχορεύεις ἔχων περὶ σεαυτὸν τοὺς χοροὺς τῶν ἀστέρων, οὕτω καὶ τὴν οἰκουμένην πᾶσαν διέπεις· Μίθραν σε Πέρσαι λέγουσιν, Ὧρον Αἰγύπτιοι (σὺ γὰρ εἰς κύκλον τὰς ὥρας ἄγεις), Διόνυσον Θηβαῖοι, Δελφοὶ δὲ διπλῇ προσηγορίᾳ τιμῶσιν, Ἀπόλλωνα καὶ Διόνυσον λέγοντες·

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Michael Psellus Polyhist., *Oratoria minora*

E la luna e il resto della danza delle stelle?

…

Ma le nostre stelle imitano la danza delle stelle in movimento e tortuose, mostrando l'anima che è dentro.

καὶ τὴν σελήνην καὶ τὸν λοιπὸν τῶν ἀστέρων χορόν;

…

ἀλλὰ τὰ ἡμέτερα ἀστέρων μιμεῖται χορὸν κινούμενα καὶ περιελιττόμενα καὶ τὴν ψυχὴν ἔνδον δεικνύντα χορεύουσαν.

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Joannes Damascenus Scr. Eccl., Theol., Passio sancti Artemii

O cosa c'è di più luminoso e dignitoso della danza delle stelle?

ἢ τί τοῦ χοροῦ τῶν ἀστέρων ἡδύτερόν τε καὶ εὐπρεπέστερον;

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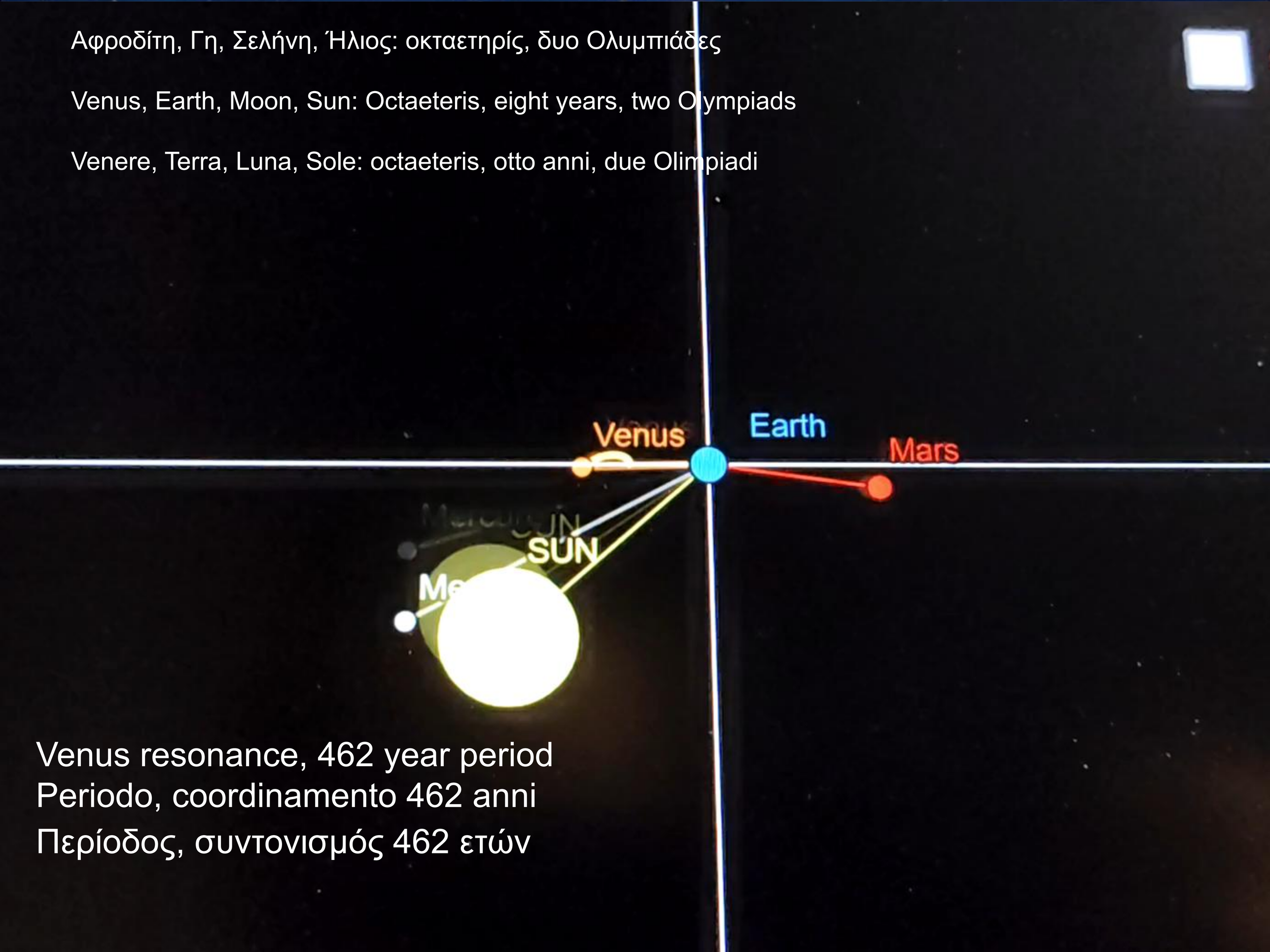
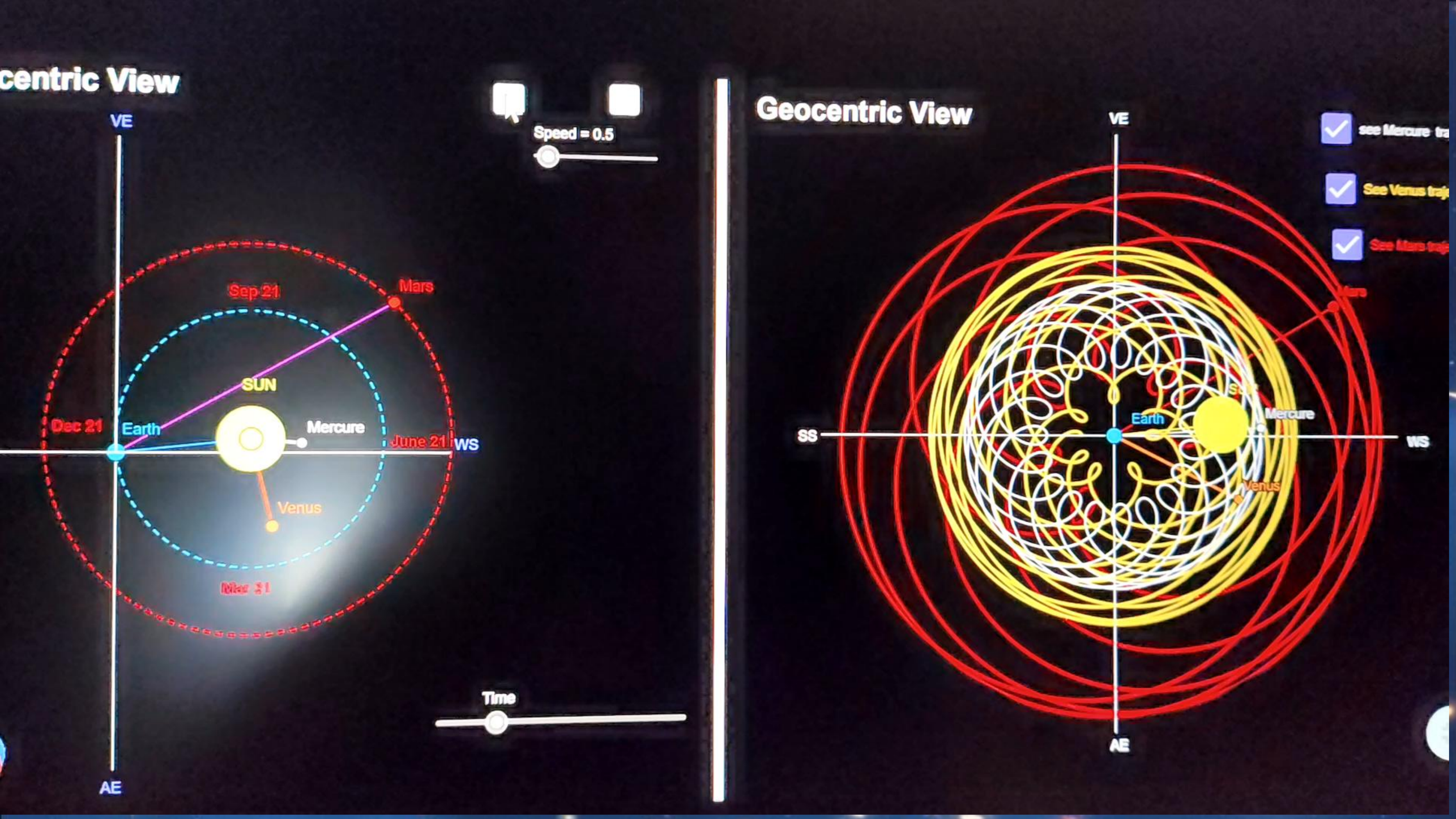
Αφροδίτη, Γη, Σελήνη, Ήλιος: οκταετηρίς, δυο Ολυμπιάδες

Venus, Earth, Moon, Sun: Octaeteris, eight years, two Olympiads

Venere, Terra, Luna, Sole: octaeteris, otto anni, due Olimpiadi



Venus resonance, 462 year period
Periodo, coordinamento 462 anni
Περίοδος, συντονισμός 462 ετών



Periodi, risonanze di 462 e 442 anni
Περίοδοι, συντονισμοί 462 και 442 ετών

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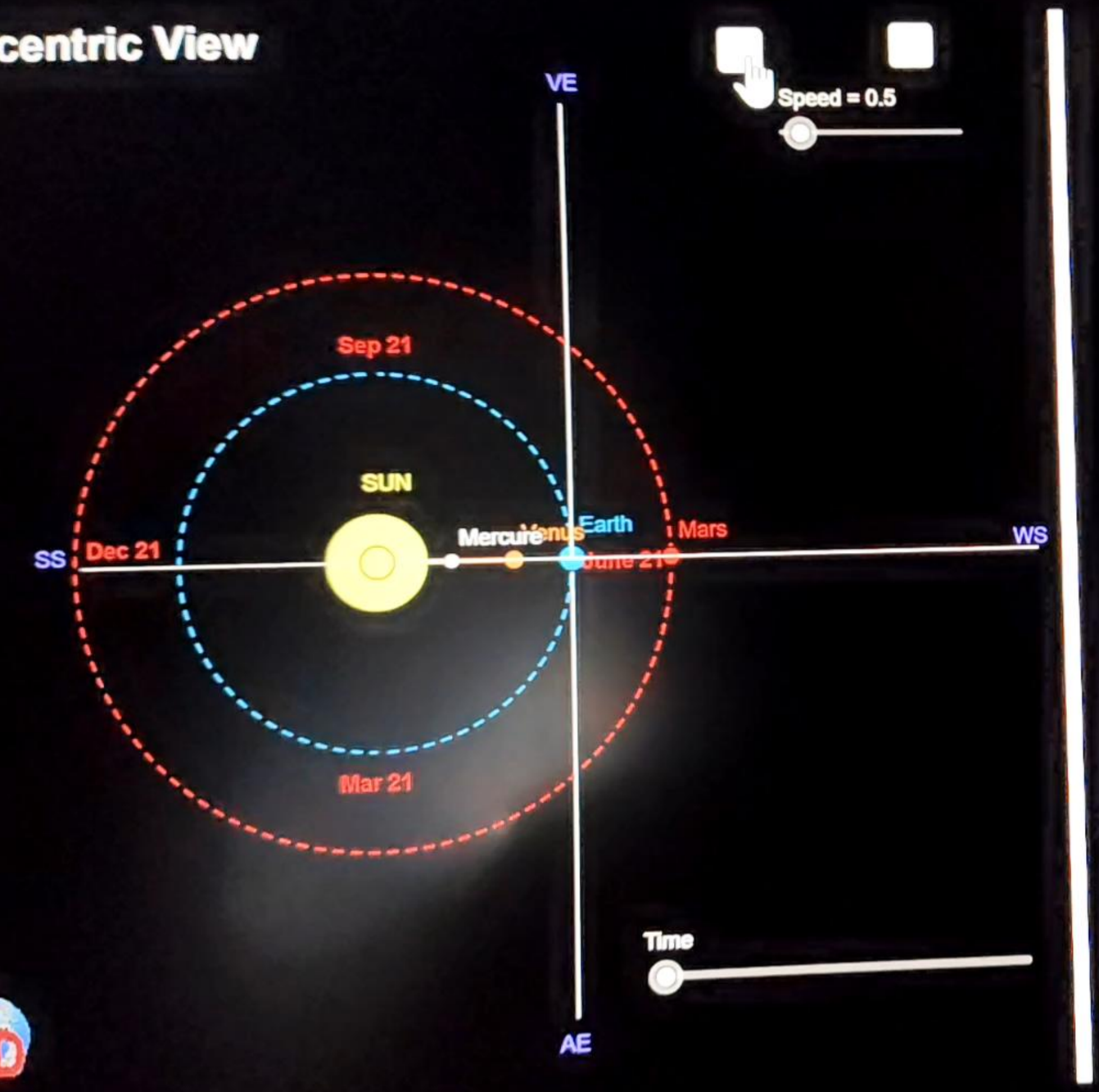

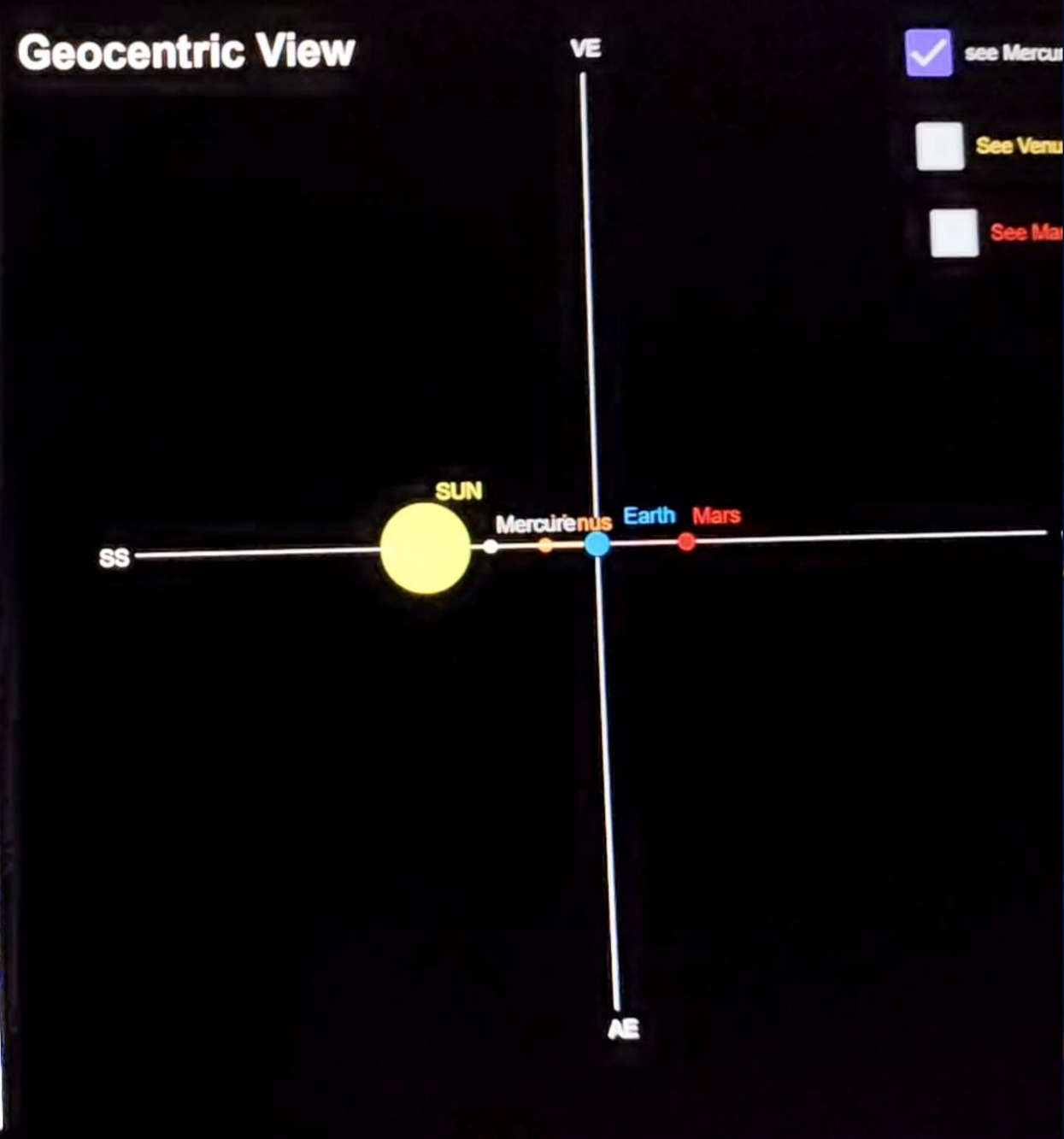

Mercury
Mercurio
Ερμής

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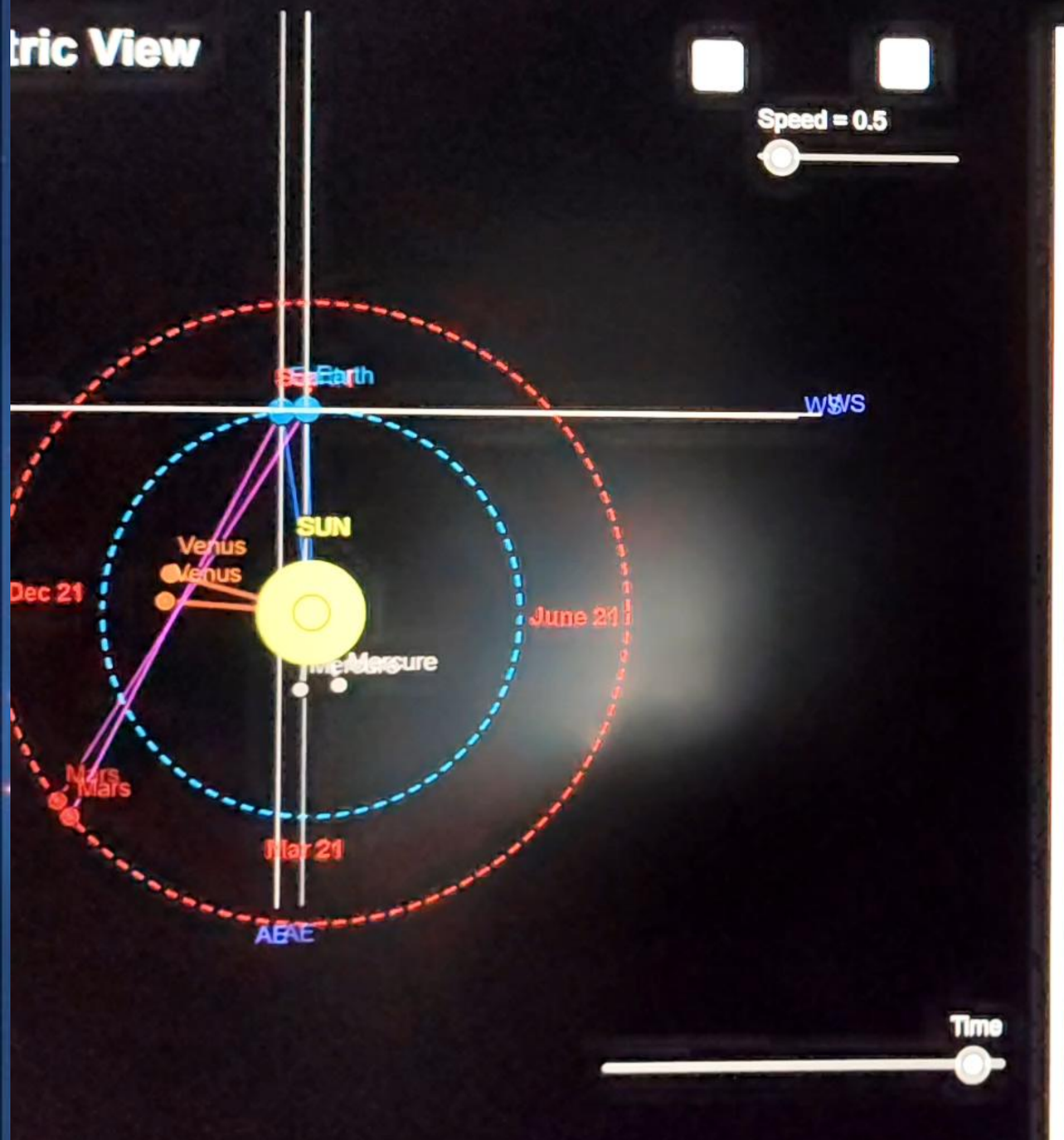

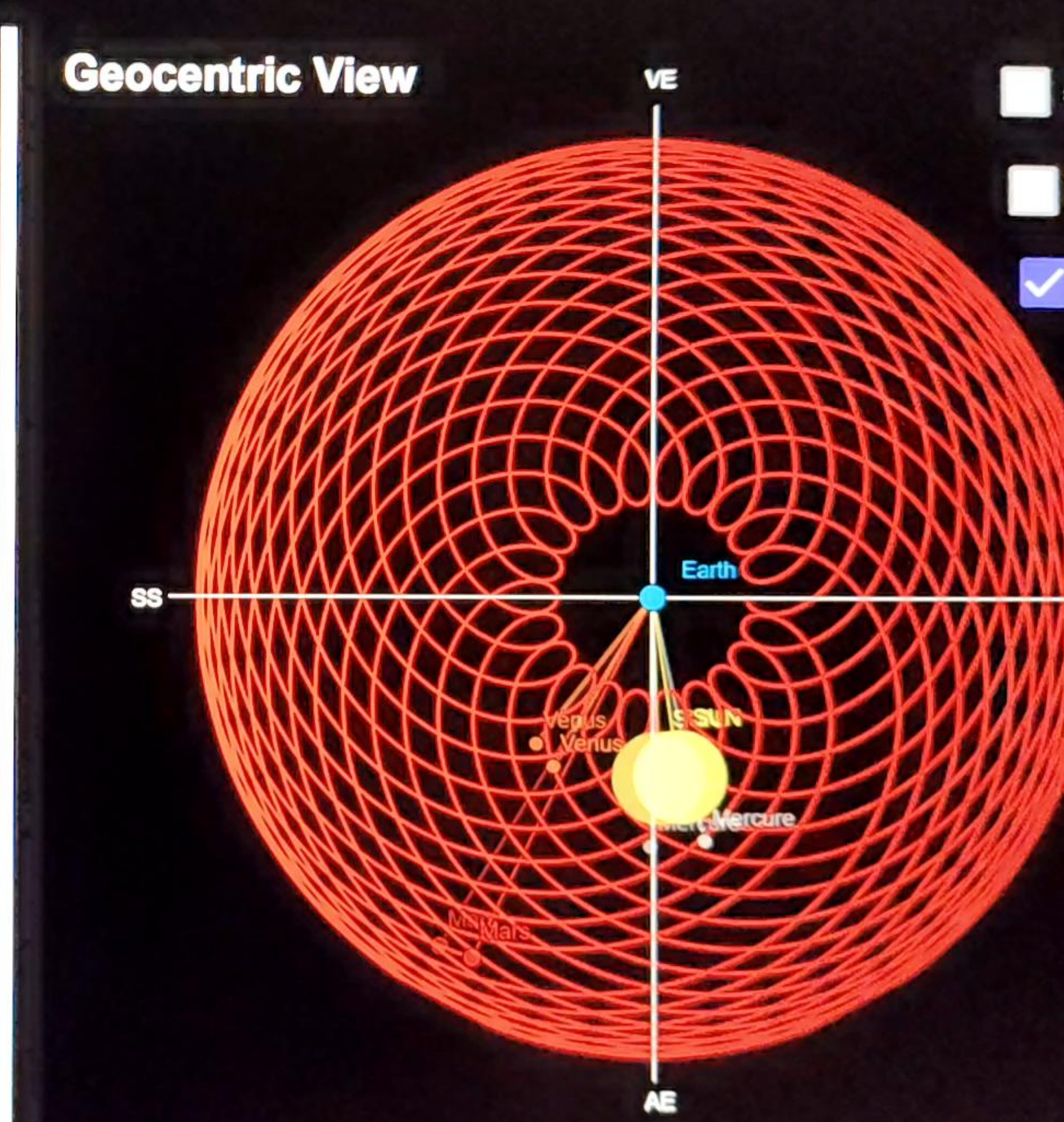

Marzo
Mars
Άρης

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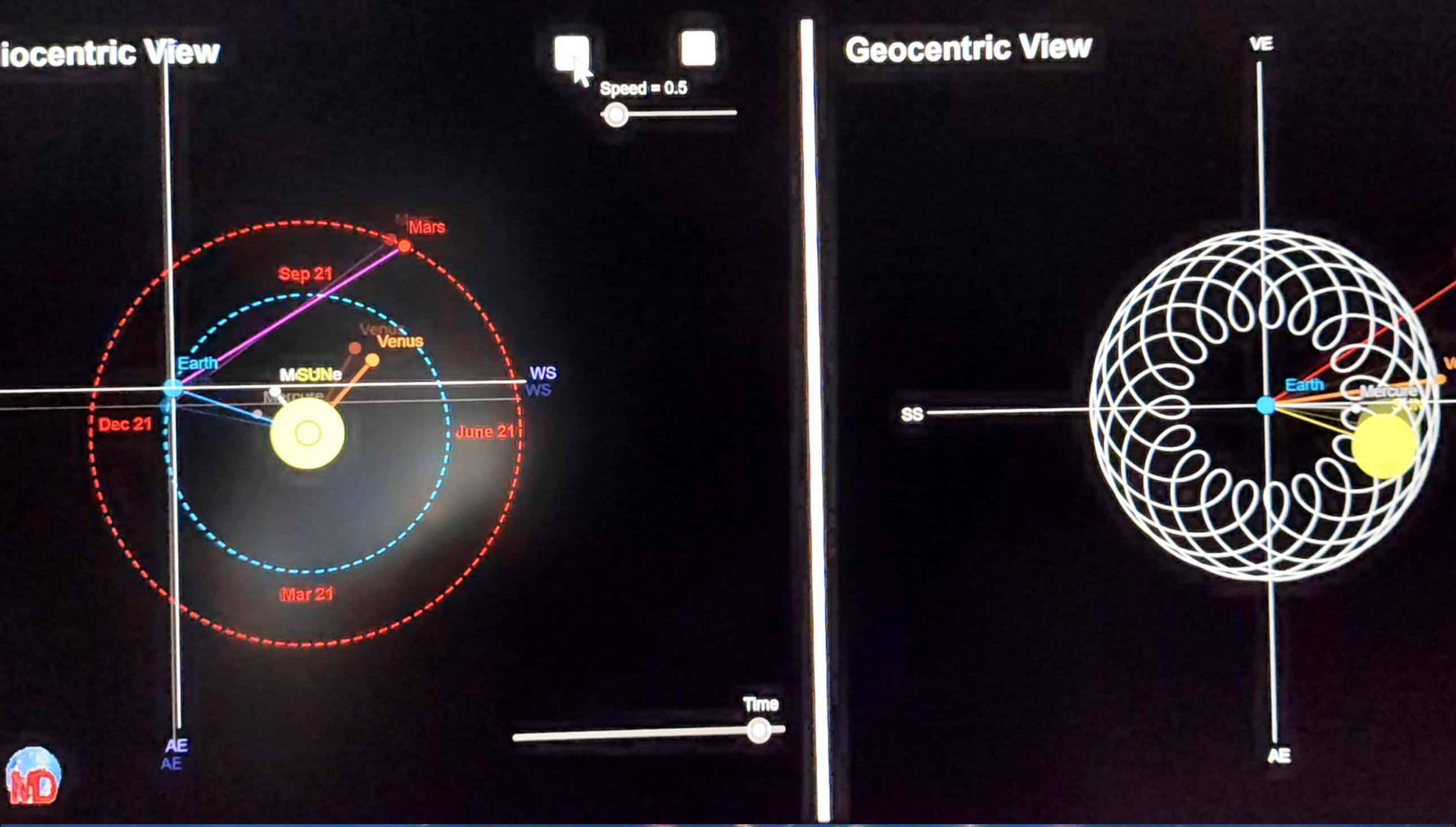

Mercurio, Mercury
Ερμής

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Numbers and symmetries
Αριθμοί και συμμετρίες

- Pseudoplutarch, Ψευδοπλούταρχος

- Πάλιν δ' ἀπ' ἄλλης ἀρχῆς Πυθαγόρας Μνησάρχου Σάμιος, ὁ πρῶτος φιλοσοφίαν τούτῳ τῷ ῥήματι προσαγορεύσας,
- ἀρχὰς τοὺς ἀριθμοὺς καὶ
- τὰς συμμετρίας τὰς ἐν τούτοις, ἃς καὶ ἁρμονίας καλεῖ, τὰ δ' ἐξ ἀμφοτέρων
- σύνθετα στοιχεῖα, καλούμενα δὲ γεωμετρικά·

- E ancora, da un'altra autorità, Pitagora Mnesarchus Samios, che fu il primo a rivolgersi alla filosofia in questo mondo,
- iniziando i numeri e
- le simmetrie che però chiama anche armonia, e quelle di entrambi
- elementi compositi, chiamati geometrici;

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- 1. Nicomachus of Gerasa (1st–2nd century AD) – Enchiridion Harmonicum
- Nicomachus describes how Pythagoras discovered the harmonic nature of the cosmos:
- E Pitagora fu il primo a dire le sfere del mondo e gli intervalli in cui ciascuna è presente per corrispondere alle sinfonie musicali.
- Πυθαγόρας δὲ πρῶτος ἔφη τὰς τοῦ κόσμου σφαίρας καὶ τὰ διαστήματα ὧν ἕκασται κεῖται ἀναλογεῖν ταῖς μουσικαῖς συμφωνίαις.
- (Pitágoras fue el primero en decir que las esferas del cosmos y los intervalos entre ellas corresponden a armonías musicales.)
- (Pythagoras was the first to say that the spheres of the cosmos and the intervals between them correspond to musical harmonies.)

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- 2. Iamblichus (c. 245–325 AD) – Life of Pythagoras (Βίος Πυθαγόρου), 15.87
- Iamblichus elaborates on how the heavenly bodies produce a harmony that is not audible to humans:
- Ἐδόκει δὲ καὶ τὸν οὐρανὸν ᾄδειν καὶ εἶναι συμφωνίαν ὑπερφυᾶ καὶ θείᾳ μάλιστα μουσικῇ προσφερομένην.
- Ed è anche piacevole al cielo, ed è una sinfonia soprannaturale e persino divina offerta nella musica.
- (Se creía que los cielos cantan y que existe una armonía más allá de la naturaleza, muy adecuada para la música divina.)
- (It was believed that the heavens sing and that there exists a harmony beyond nature, most fitting to divine music.)

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- 3. Proclus (5th century AD) – Commentary on Plato’s Republic, 617b
- Proclus, commenting on Plato, connects Pythagoras' ideas to celestial motion:
- Οἱ Πυθαγόρειοι δὲ λέγουσιν ὅτι ὁ κόσμος τῇ τοῦ νοῦ δυνάμει κινεῖται, καὶ ἐν ταῖς κινήσεσιν τούτοις ἁρμονίαν τινὰ καὶ ῥυθμὸν ἀπεργάζεται.
- E i pitagorici dicono che il mondo si muove per il potere dell'intelletto, e in questi movimenti opera una certa armonia e ordine.
- (Los pitagóricos dicen que el cosmos se mueve por el poder del intelecto, y en estos movimientos se produce una cierta armonía y ritmo.)
- (The Pythagoreans say that the cosmos moves by the power of the intellect, and in these movements, it produces a certain harmony and rhythm.)

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- Plato discusses the "music of the spheres" and the "dance of the planets"
- Platone discute della "musica delle sfere" e della "danza dei pianeti"

- primarily in the Republic (Book X) and in the Timaeus. Below are exact Greek quotations from his works:
- 1. The Republic (Book X, 617b–617d) – The Spindle of Necessity and the Harmony of the Spheres
- In Republic 10, Plato describes the Spindle of Necessity, a cosmic structure around which the planets move in a system of concentric circles, each producing a distinct tone, forming a celestial harmony:
- Ἔχουσα δὲ ἡ σφαῖρα τοῦ ἀνάγκης ἔχετο ἐν τῇ τῆς ἀνάγκης γόνῃ, τὸν δὲ κύκλον ἐντὸς τοῦ αὐτοῦ τοῦ ἄξονος περιφερόμενον ἑαυτῷ ὁμοίως ἔφερεν.
- Οἱ δὲ κύκλοι τοῦ οὐρανοῦ ὀκτὼ ἦσαν, ἕκαστος ἄλλην φωνὴν ἀπεδίδου, ὥστε μίαν ἁρμονίαν ἀπεργάζεσθαι.
- (Translation: "The sphere of Necessity was seated in the lap of Necessity, and the revolving spindle turned within her. The orbits of the heavens were eight in number, and each emitted a different note, forming a single harmony.")
- This passage establishes the idea that each planetary sphere produces a tone, creating a cosmic scale of harmony.
- 2. Timaeus (36c–37a) – The Cosmic Dance and Harmonic Ratios
- In the Timaeus, Plato explains how the Demiurge arranged the celestial bodies according to mathematical harmonies:
- Καὶ διὰ ταῦτα πᾶν ἄστρων γένος, ὅσα τε πλανητὰ καὶ ὅσα ἀπλανῆ, διεκόσμησεν κατὰ τὴν σύμμετρον καὶ νοητὴν ἀριθμῶν καὶ ἁρμονίας δύναμιν.
- (Translation: "And for this reason, He arranged all the stars, both those that wander and those that remain fixed, according to the proportional and intelligible power of number and harmony.")
- This suggests that the motion of the celestial bodies follows mathematical and harmonic principles, aligning with the Pythagorean and Platonic concept of a universe governed by numerical order and musical harmony.
- 3. Laws (VII, 817b–c) – The Dance of the Planets
- Plato also refers to the cosmic dance of the stars and planets in Laws:
- Καὶ γὰρ ἡμῖν καὶ τοῖς ἄλλοις ἅπασιν θεοῖς, ὡς τὸν ἄνω κύκλον αὐτοῖς ἰόντα καὶ ἰόντα κατὰ νόμον ἀεὶ καὶ ἀνάγκην, μετ᾽ ἀληθοῦς μουσικῆς χρῆναι χορεύειν.
- (Translation: "For both we and all the other gods, seeing the upper cycle moving according to law and necessity, must dance in accordance with true music.")
- This passage reinforces the idea that the movement of the planets is a divine dance following strict harmonic principles.

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Woodcut: Pythagoras observing the hammer experiment, experimenting with bells, glass harmonica, polychord (a string organ) and pipes in Pythagorean tuning. From Theorica musicae by Franchino Gaffurio, 1492 (1480?), Wikimedia

siamo tutti pitagorici

We are all Pythagoreans

όλες και όλοι είμαστε Πυθαγόρειοι

Todas somos pitagóricas Todos somos pitagóricos

Pythagoras measured the hammers and discovered that the ones making harmonious sounds had weights 12, 9, 8, and 6 pounds.

The weights ratios are

12:8 or 3:2, which is the perfect fifth,

12:9 or 4:3, the perfect fourth).

and

9:8. These are all simple ratios

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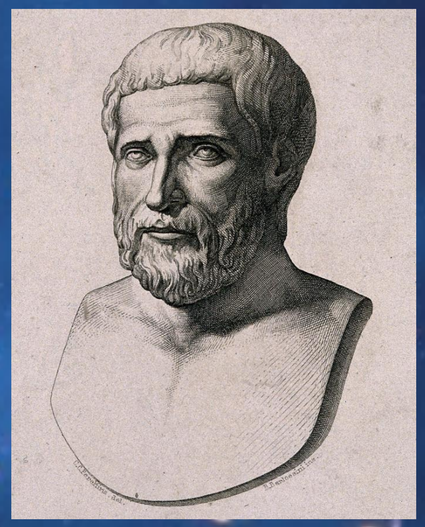

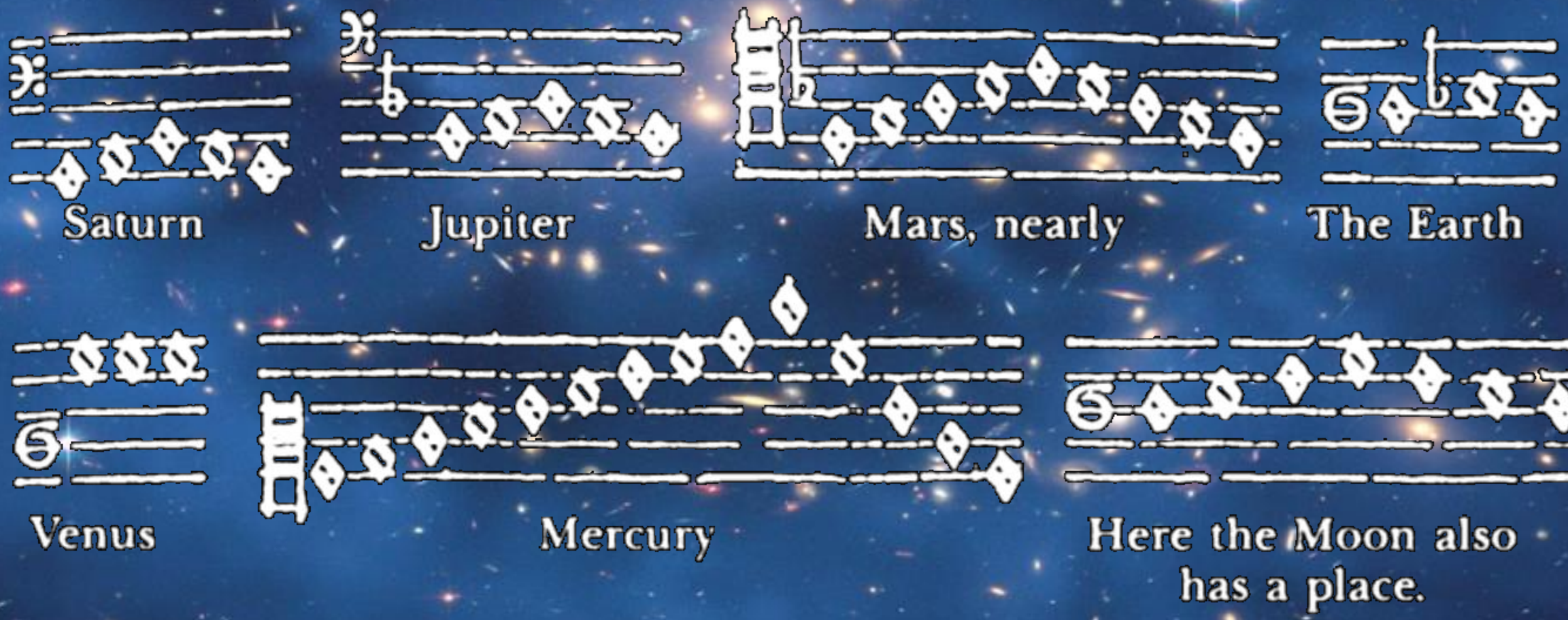

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Giovanni Lido (Ioannis Laurentios Lidos):
LA MUSICA DELLE SFERE
(l'armonia del Cosmo)
testo di Giovanni Lido (Ioannis Lavrentios),
il suo libro Sui mesi:
Tutti i ritmi del movimento dei pianeti
stanno avvenendo;
Per Crono a Doriano,
E Zeus il Frigio,
E Ares a Lidio, e
gli altri si muovono secondo Pitagora
al suono delle vocali;
Per Hermos, che fu il primo,
E Afrodite la e,
E il sole la H,
E quello di Crono I,
E quello di Ares,
e Luna tua,
Che non è la stella di Zeus, che è la stella di Zeus;
E il suono delle parole mentre non
veniamo a causa della distanza.

Ιωάννης Λύδος
Η ΜΟΥΣΙΚΗ ΤΩΝ ΣΦΑΙΡΩΝ
(η αρμονία του Κόσμου)
κείμενο του Ιωάννη Λαυρέντιο,
βιβλίο του *Περί Μηνών*:
Πάντας τοὺς ῥυθμοὺς ἐκ τῆς τῶν πλανήτων κινήσεως εἶναι συμβαίνει·

1. *ὁ μὲν γὰρ Κρόνος τῷ Δωρίῳ,*
2. *ὁ δὲ Ζεὺς τῷ Φρυγίῳ,*
3. *ὁ δ' Ἄρης τῷ Λυδίῳ καὶ*

οἱ λοιποὶ τοῖς λοιποῖς κινοῦνται ***κατὰ τὸν Πυθαγόραν***
πρὸς τὸν ἦχον τῶν φωνηέντων·

1. *ὁ μὲν γὰρ Ἑρμοῦ τὸν α,*
2. *ὁ δ' Ἀφροδίτης τὸν ε,*
3. *ὁ δ' Ἥλιος τὸν η,*
4. *καὶ ὁ μὲν τοῦ Κρόνου τὸν ι,*
5. *ὁ δὲ τοῦ Ἄρεος τὸν ο,*
6. *καὶ Σελήνη τὸν υ,*
7. *ὅ γε μὴν τοῦ Διὸς ἀστὴρ τὸν ω ῥυθμὸν ἀποτελοῦσιν·*

ὁ δὲ ἦχος τῶν ῥυθμῶν ὡς ἡμᾶς οὐκ ἀφικνεῖται διὰ τὴν ἀπόστασιν.

Grazie mille!

πολλές ευχαριστίες!

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Iniziativa inserita nell'ambito dell'Olimpiade Culturale di Milano Cortina 2026