

PLANETS: A HISTORIC AND CULTURAL REVIEW

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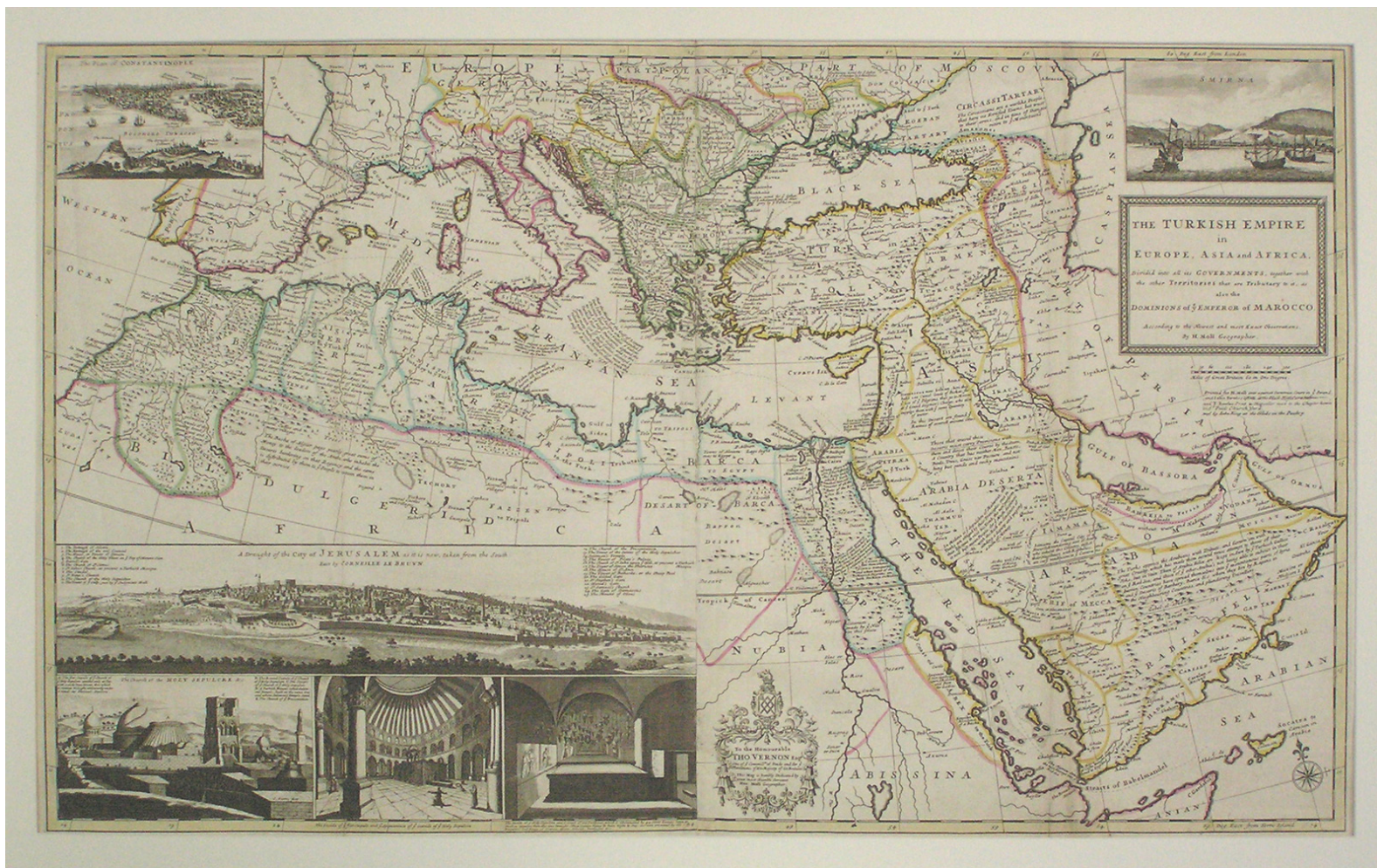
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Nebra sky disk (1600 BC - found in 1999 in Germany)

Sun – Lunar crescent – stars (Pleiades)



South of Europe and Middle East around 1600 AD
[= after Jesus Christ].

Development of astronomy:

I. Babylon (\approx 3000 BC [= Before Christ]) \rightarrow

II. Ancient Greece (600 – 200 BC) \rightarrow

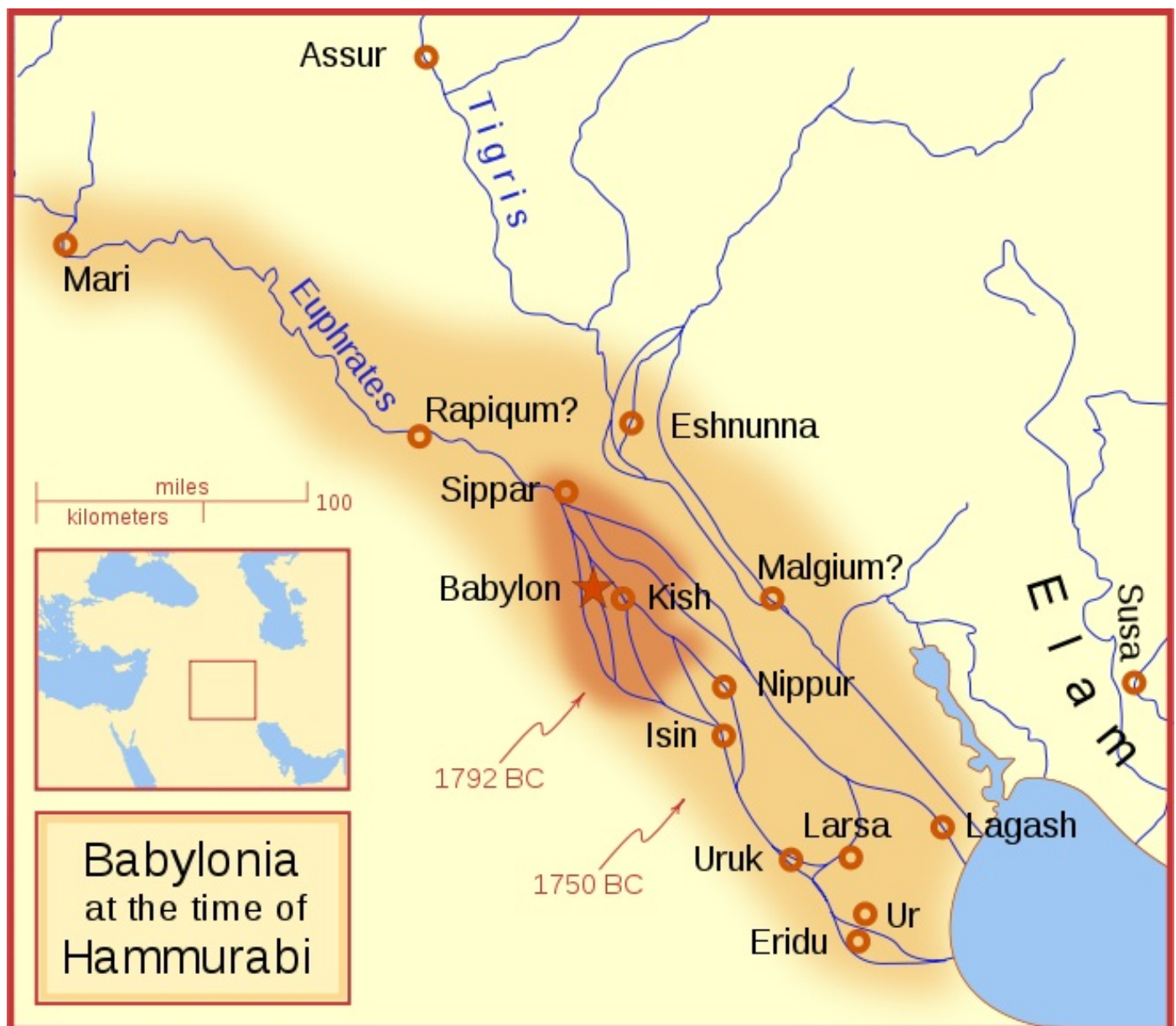
III. Europe (1500 – 1700 AD)

I. MESOPOTAMIA

[greek: "between rivers" Tigris, Euphrates] Astronomy born in \approx 3000 BC

Sumer, Akkad, Babylon, Assyria





first city : **Ur** (**Sumer**) \approx 8000 BC

Sumerian (\approx 3500 BC) invent writing : information stored on clay tabletts in cuneiform [=wedge-shaped], written with blunt reed. Decyphered around 1850.



Man-made hill found in South of Irak. Excavations allow to discover the city of Ur.

Religious-astronomical tablets

“Nanna [Moon], great lord, light shining in the clear skies, wearing on his head a prince’s headdress right god for bringing forth day and night, establishing the month bringing the year to completion.”



“Inanna [Venus]

Great Queen of the Sky”

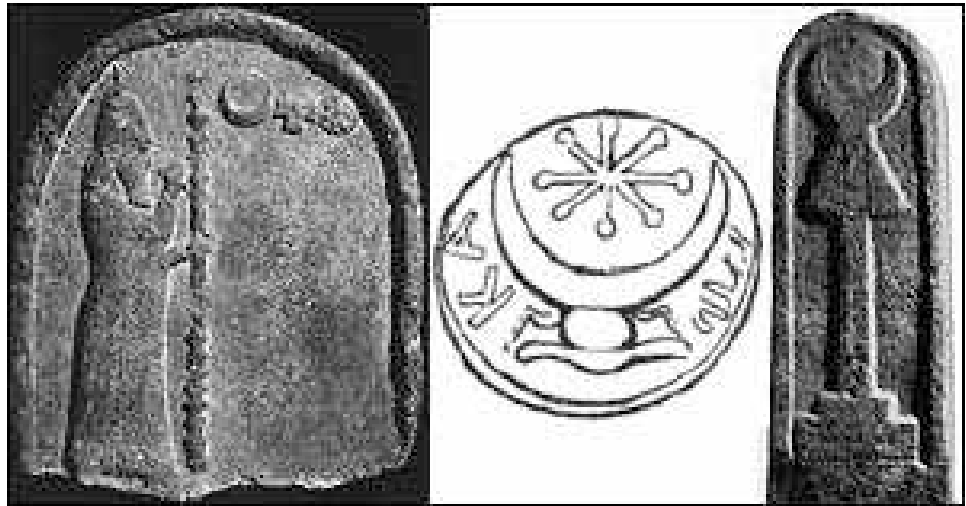


Ziggurath built by **Ur-Nammu** (2112 – 2095 BC)
[reconstructed]

Astronomical observatory AND temple

Astronomy (science) AND religion

Chaldeans [priest - astronomers] observe



Sin = Moon



Istar = Venus

Nergal = Mars Nebo = Mercure

main God : **Marduk** = **Jupiter**



Sumerians celebrated a **SPRING FESTIVAL** for the Lunar New Year. In Babylonia, 12 days of festivities, dedicated to **Marduk**'s victory over Tiamat [chaos monster].)

Ex. :

First to third Day

The priest of Éšagila (Marduk's house) would recite sad prayers with the other priests and the people would answer with equally sad prayers which expressed humanity's fear of the unknown. This fear of the unknown explains why the high priest would head to the Éšagila every day asking for Marduk's forgiveness, begging him to protect Babylon, his holy city.

Fourth Day

The same rituals would be followed as in the previous three days then at night the Epic of Creation Enuma Elish would be recited, telling the story of how the universe and the seasons were created, then [how all gods united in god Marduk following his victory over Tiamat](#).

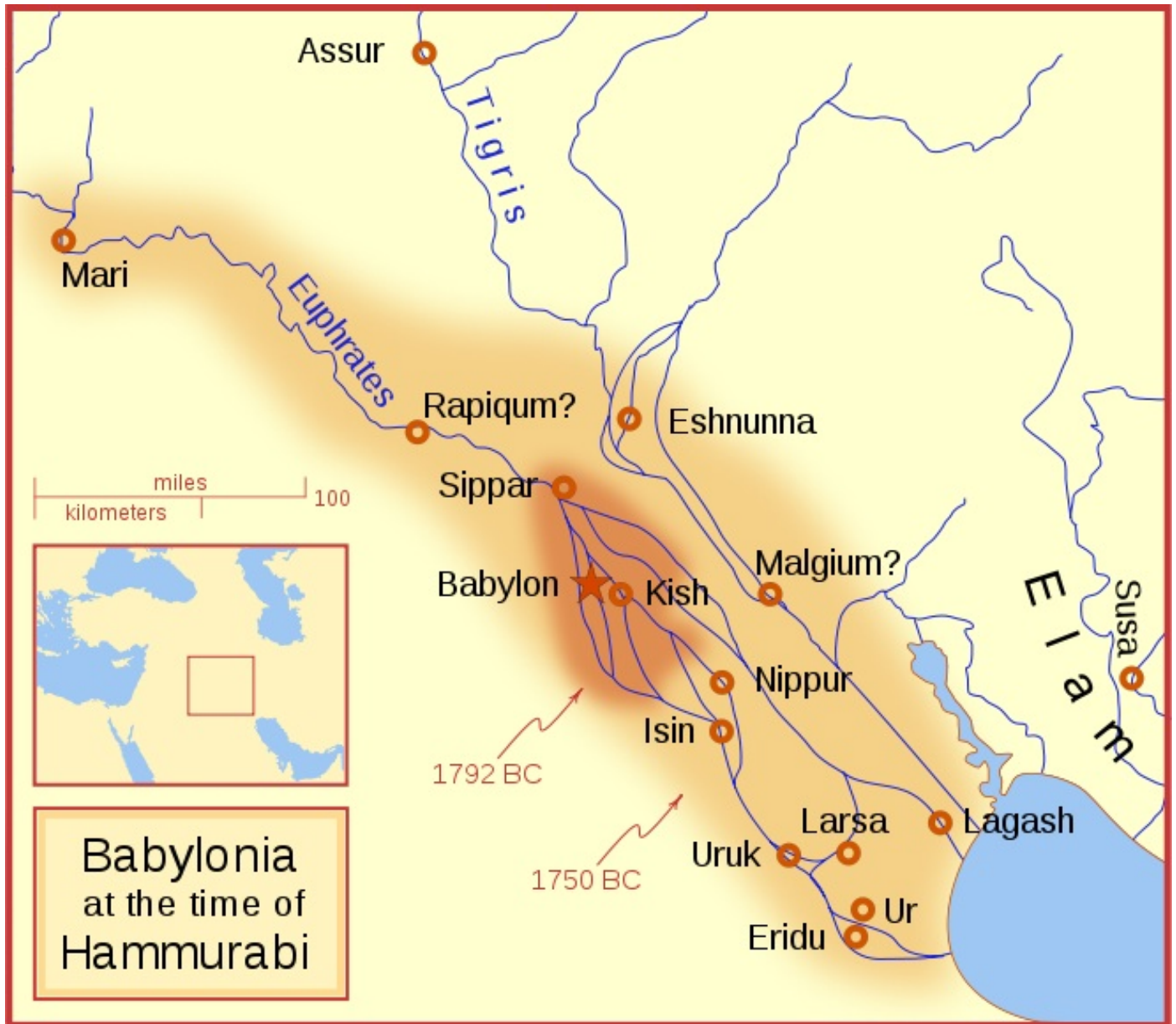
The recitation of this Epic was considered the beginning of preparations for the submission of the King of Babylon before Marduk on the fifth day.

:

Twelfth Day

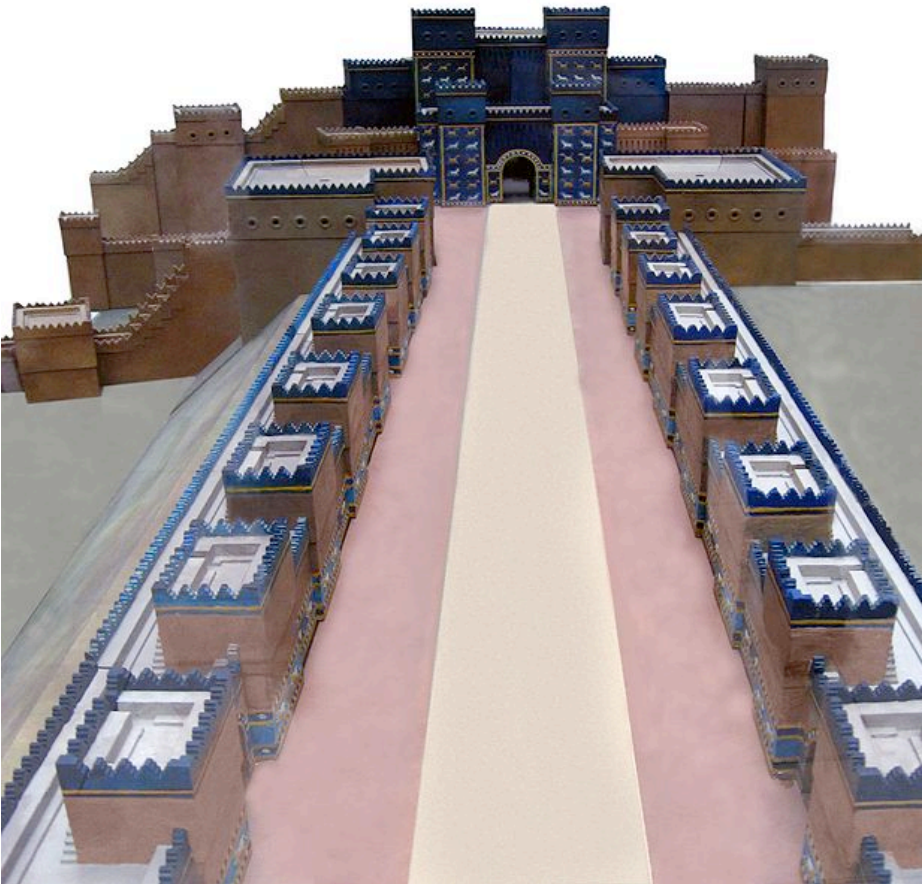
The gods return to Marduk's temple (the statues are returned to the temple) and daily life resumes.

Babylon -1792 [akkadian: Bâb-allah (God's Gate = Tian Men ?)].





Excavations of Babylon in 1932



Processional way (reconstructed).



Ishtar Gate (Pergamon Museum Berlin Germany)

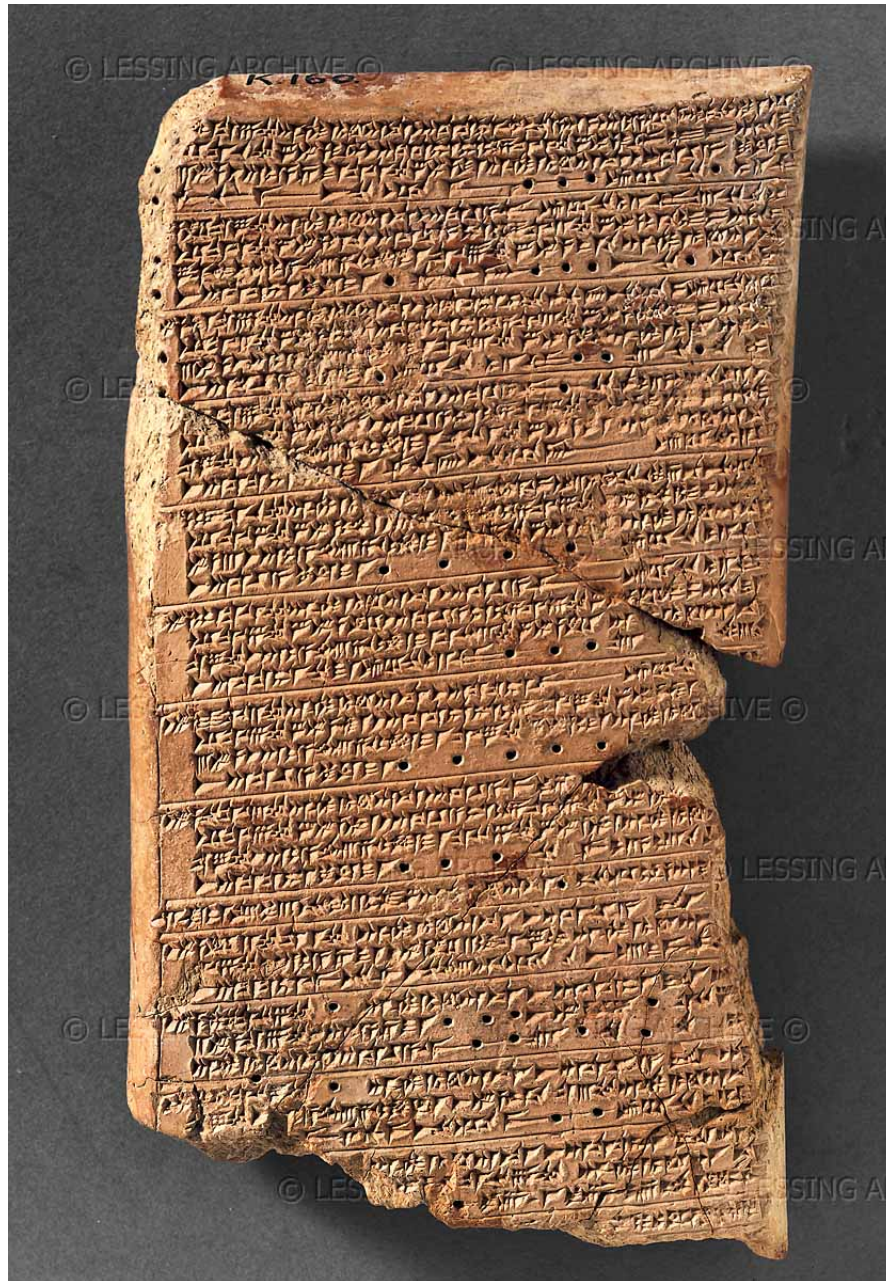




A Babylonian almanac, mentioning future positions of the planets



Tablet with a list of eclipses between 518 and 465 BC. (British Museum)



Venus tablet of Ammisaduqa 1700 BC

The tablet recorded the rise times of Venus and its first and last visibility on the horizon before or after sunrise and sunset in the form of lunar dates. These observations are recorded for a period of 21 years.

Observations :

Year 1 inferior Venus sets on Shabatu 15 and after 3 days rises on Shabatu 18

Year 2 superior Venus vanishes E on Arahsumnu 21 and after 1 month 25 days appears W on Tebetu 16

Year 3 inferior Venus sets on Ululu 29 and after 16 days rises on Tashritu 15

Year 4 superior Venus vanishes E on Dumuzi 3 and after 2 months 6 days appears W on Ululu 9

Year 5 inferior Venus sets on Nisan 29 and after 12 days rises on Ayar 11

Year 5 superior Venus vanishes E on Kislimu 27 and after 2 months 3 days appears W on Shabatu 30

etc.

ONLY OBSERVATIONS RECORDED,

NO EXPLANATION



Tablet recording the observation of Halley's comet

Legend of Babel Tower : Bible

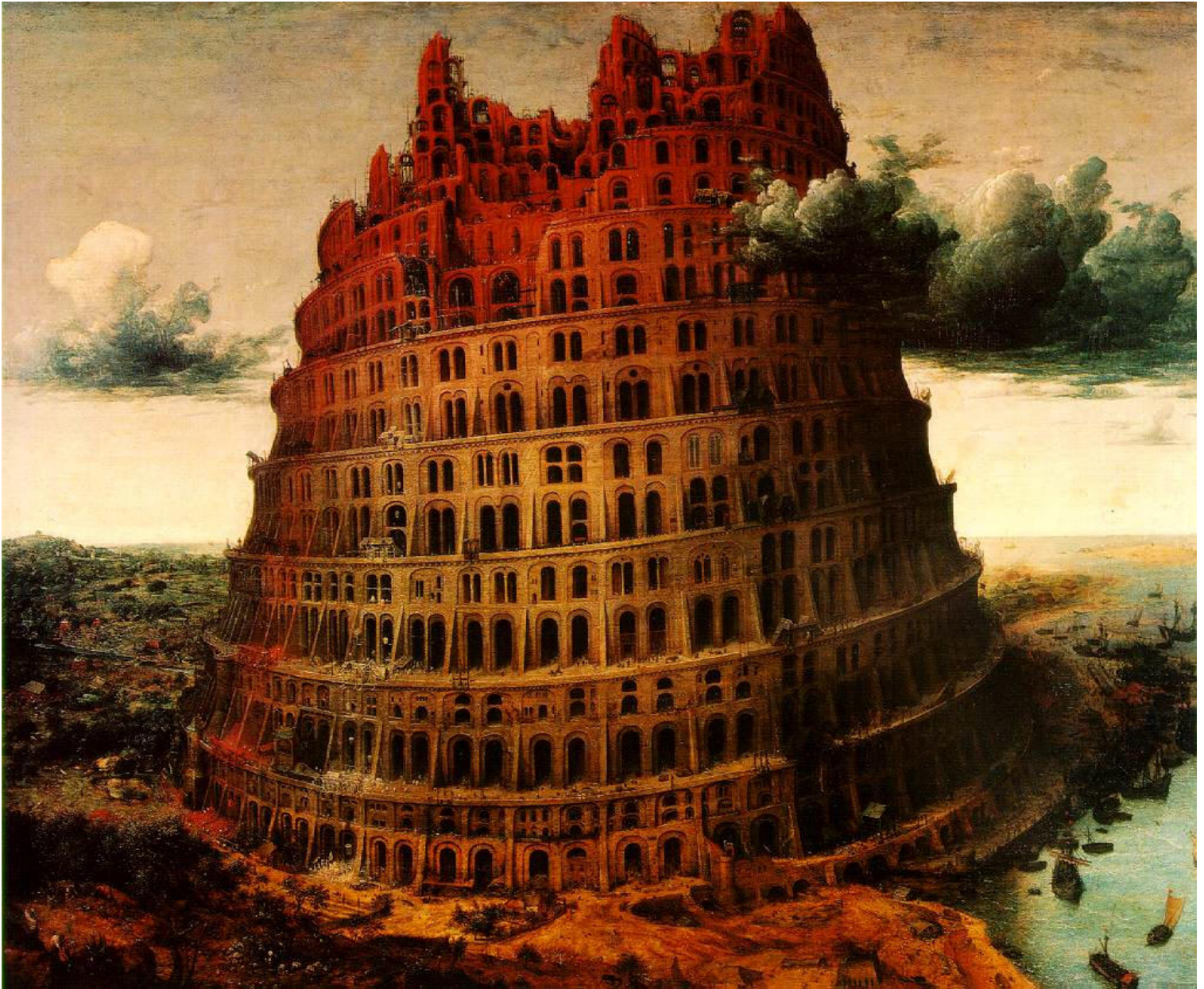
... they found a plain in the land of Sin'âr, and they dwelt there. And they said one to another, "Come, let us make bricks and burn them thoroughly". And they had brick for stone, and slime had they for mortar.

And they said, "Come, let us build us a city and a tower whose top may reach unto heaven; and let us make us a name, lest we be scattered abroad upon the face of the whole earth."

Captured phantasy of men



Lodewyk Toeput 1587 Artist's imagination



Brueghel the Old (1563)

DID THE TOWER OF BABEL EVER EXIST ?

The best description found in a cuneiform tablet from Uruk, written in 229 BC. (A copy of an older text.) It states that the tower was made up of seven terraces and it gives the height of the seven stocks -91 meters all in all.

Confirmed by archaeological excavations in 1913 !





Map of Babylon

(Later the river moved away, the city became desertic and got abandonned).

II. ANCIENT GREECE

Around 600 BC center of gravity moves westwards = Europa



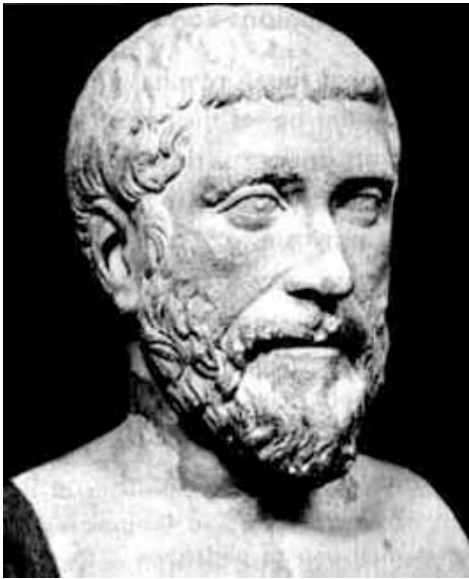
Map of Europa by Claudios Ptolemaios (Alexandria, 2e AD [= our time]). (Vatican)

Ancient Greece



Important city-states: Athens, Thebes – and also in Asia Minor (Samos, Miletus ...)





PYTHAGORAS

6th century

BC

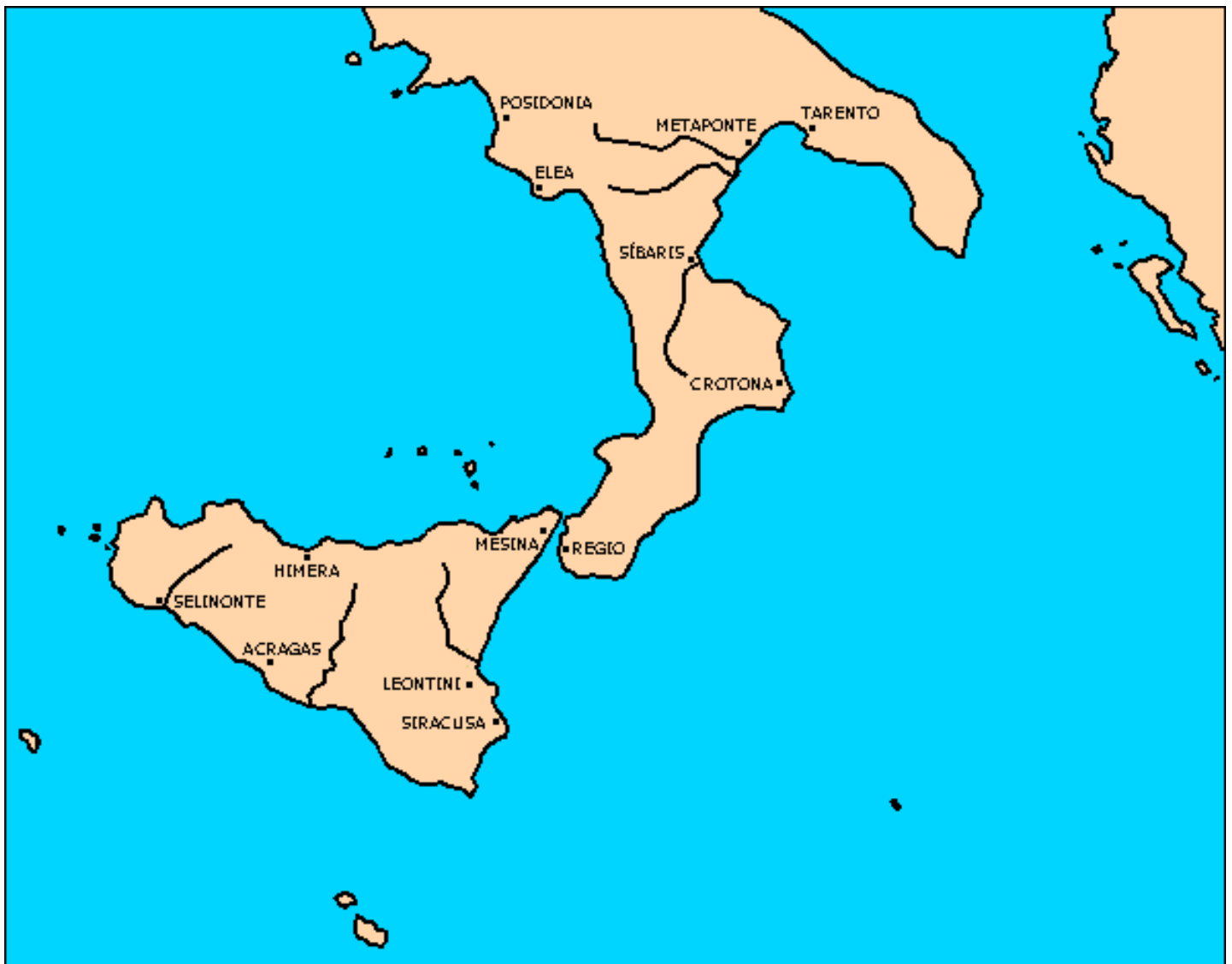


Samos

(island off coast of Asia Minor)

moves to **Grecia Magna** (South of Italy)

granary of antique world





Pythagoras temple (Metaponte)

Mathematisation of experience.

Numbers: sacred. Contain secrets of the World.

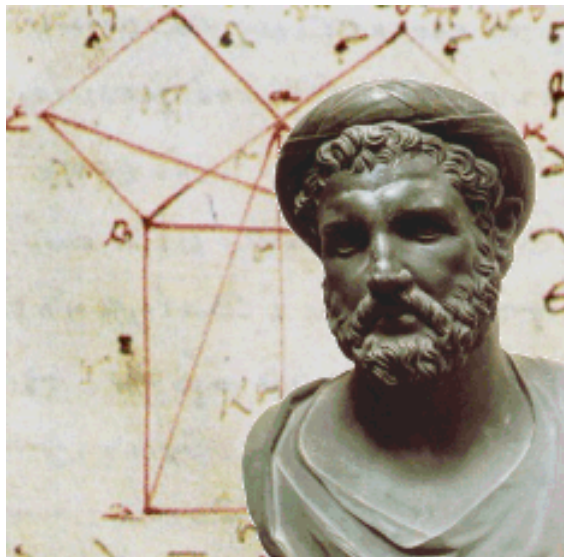


- musical harmonies
length of chords : (octave: 1:2, etc)

- Cosmos: "harmony of order" Pythagoras



(Raffaello in Vatican)

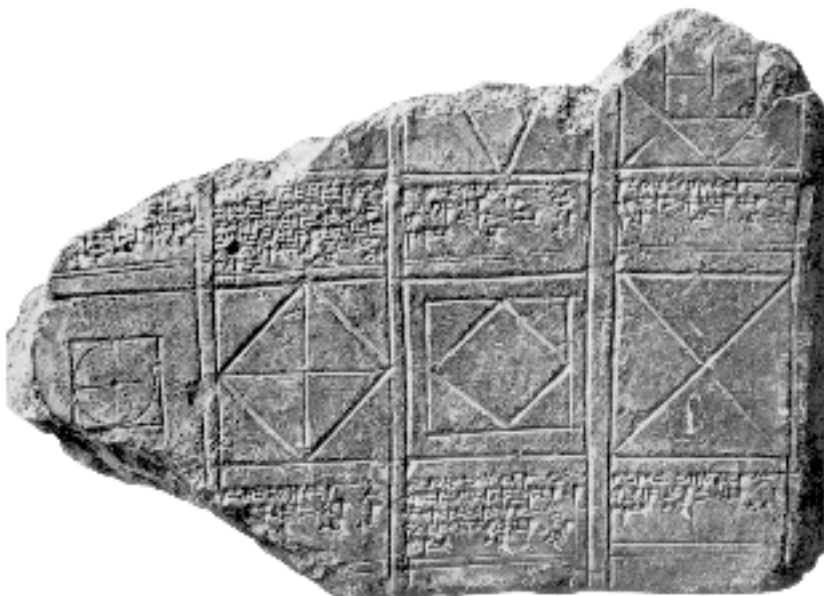


“Pythagoras’ thm”



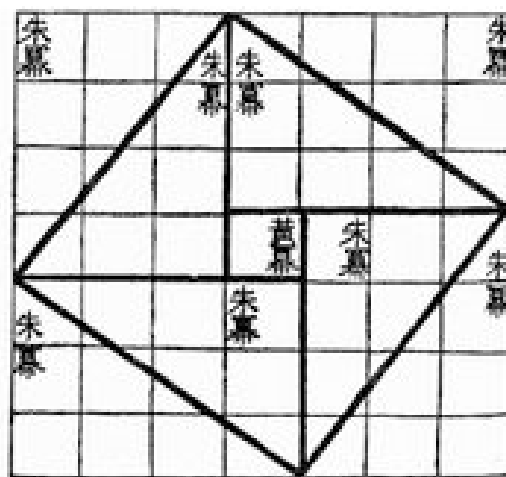
Babylon Hammurabi 1790-1750 BC.

“Plimpton tablet” : Pb whose solutions requires the knowledge of Pythagoras’ Thm



Egypt : 2000 – 1760 BC “Plimpton Papyrus”
6619 de Berlin

勾股容合以成弦圖



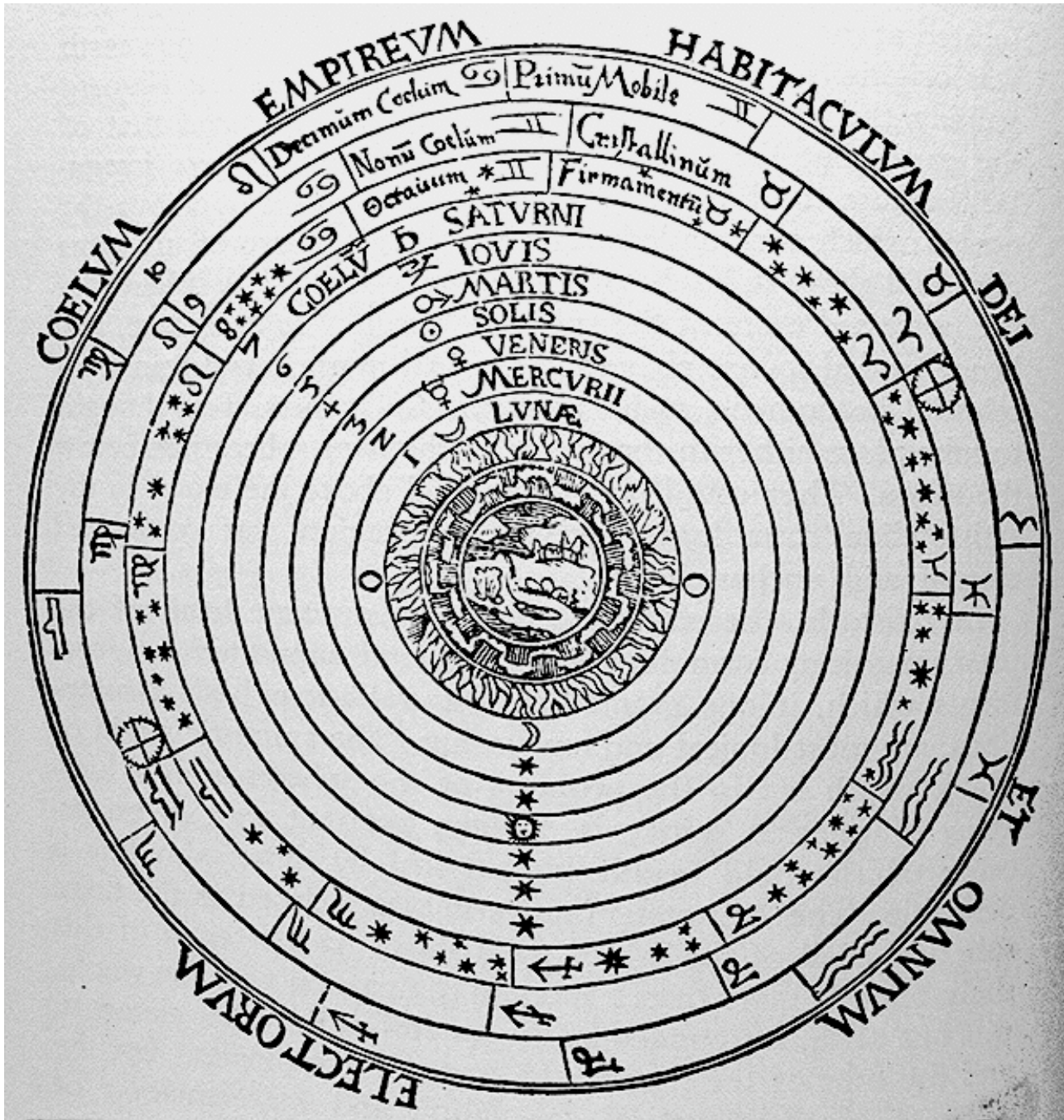
China :

Zhou Bi Suan Jing anonymous collection of 246
pbs from Zhou Dynasty (1046 BC - 256 BC)

contains one of the first recorded proof of the
Pythagorean Theorem.

HOW DOES THE WORLD LOOK LIKE ?

I. GEOCENTRIC SYSTEM



Earth : sphere. Moon, Sun, planets (“wandering stars”) turn around Earth on concentric circles.



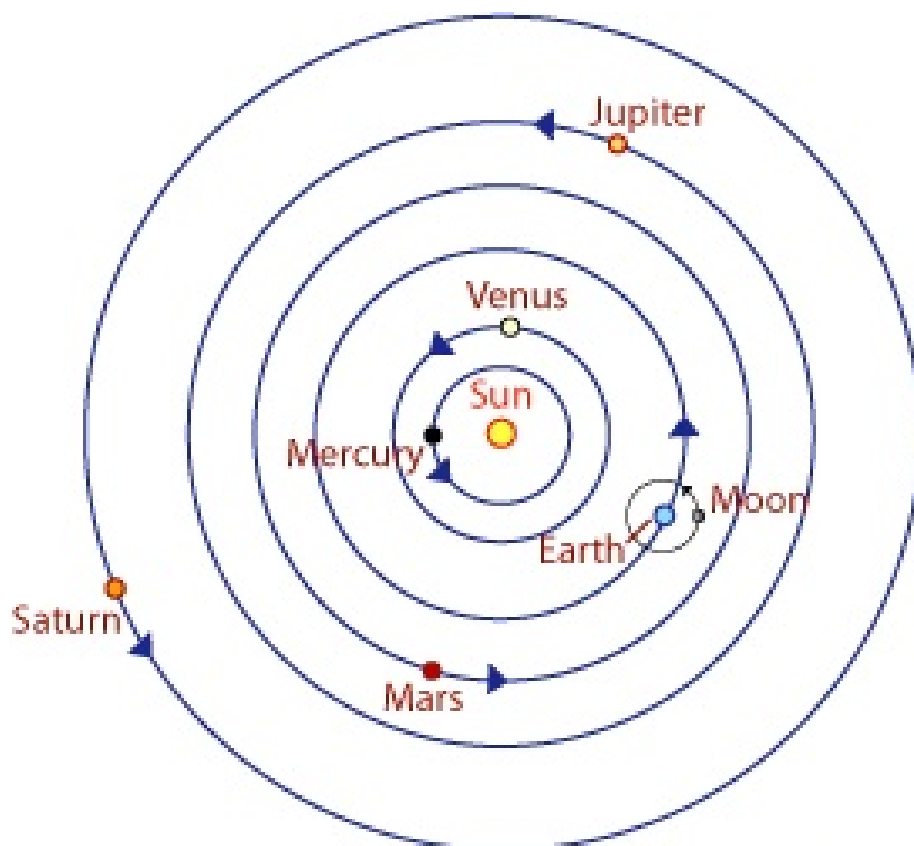
ARISTARCHOS

310 BC. Measures the Earth/Sun distance using trigonometry

II. HELIOCENTRIC SYSTEM

(Sun fixed at middle)

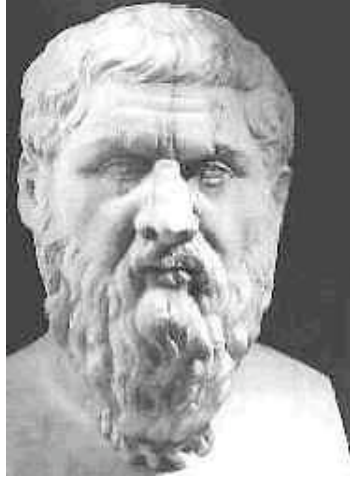
Earth revolves around Sun and also around its axes. Idem for all planets.



Aristarchus' Heliocentric Model
(Not to scale)

RETURN TO GEOCENTRIC SYSTEM

3rd BC. : sciences decline. Social instability (wars, plagues, misery).



PLATON

“phobia of mutations” .

observed world “reproduction” of patterns (IDEAS)
⇒ Study abstract problems and NOT at celestial bodies !”

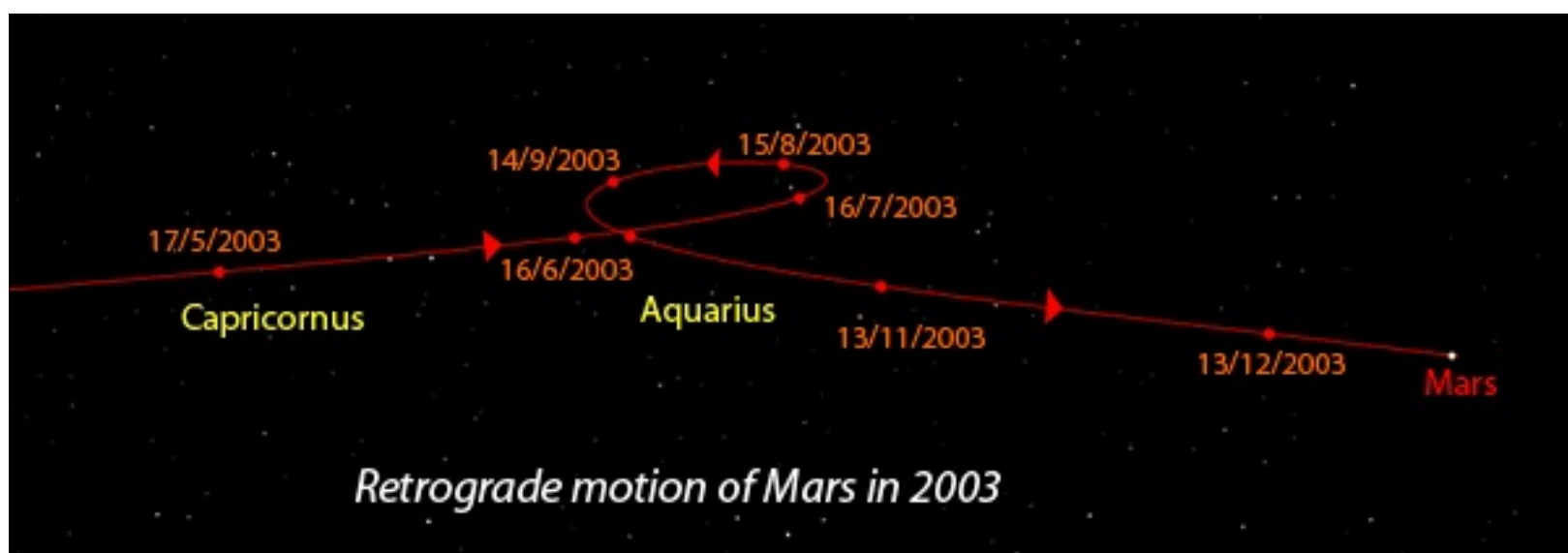
CIRCULAR DOGMA: *the World MUST have the perfect form of a sphere.*

“SAVE THE PHENOMENA” ! : Task of mathematician: explain irregular motion of planets with regular motion on perfect circles .

HERAKLEIDES (student of Platon & Aristoteles)

4th century BC : geocentric system in contradiction with observations :

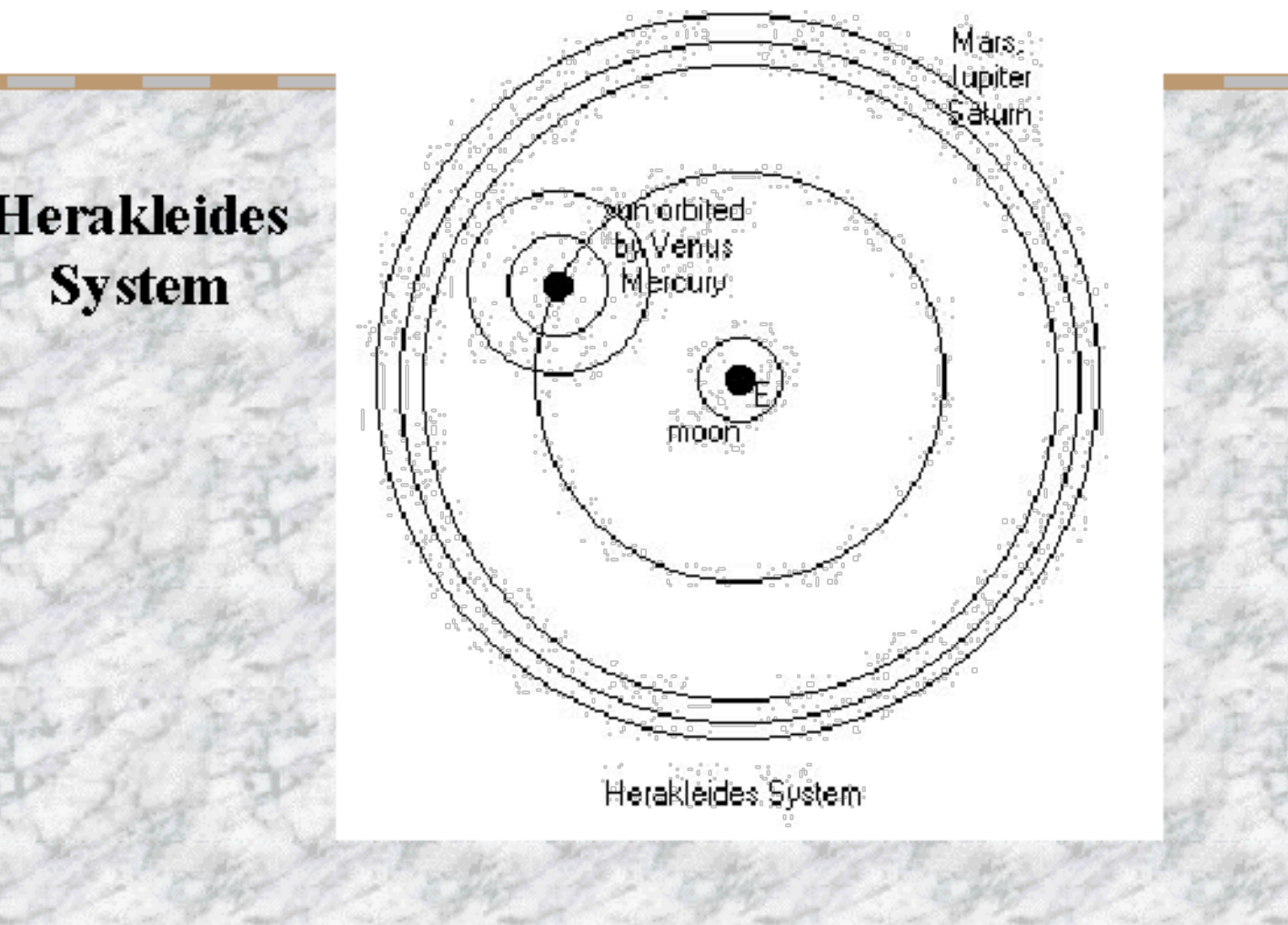
Planets: irregular (retrograde) movements.



Observes that motion of Mercure, Venus is linked to that of the Sun.

Proposes mixed system

- **Earth** fixed
- **Moon, Sun ... Mars, Jupiter, Saturn** revolve around the **Earth**



EARTH IS NOT CENTER OF UNIVERSUM



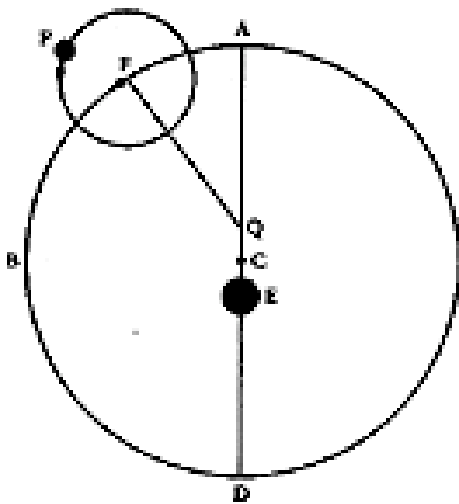
PTOLEMAIOS

2nd AD

Alexandria

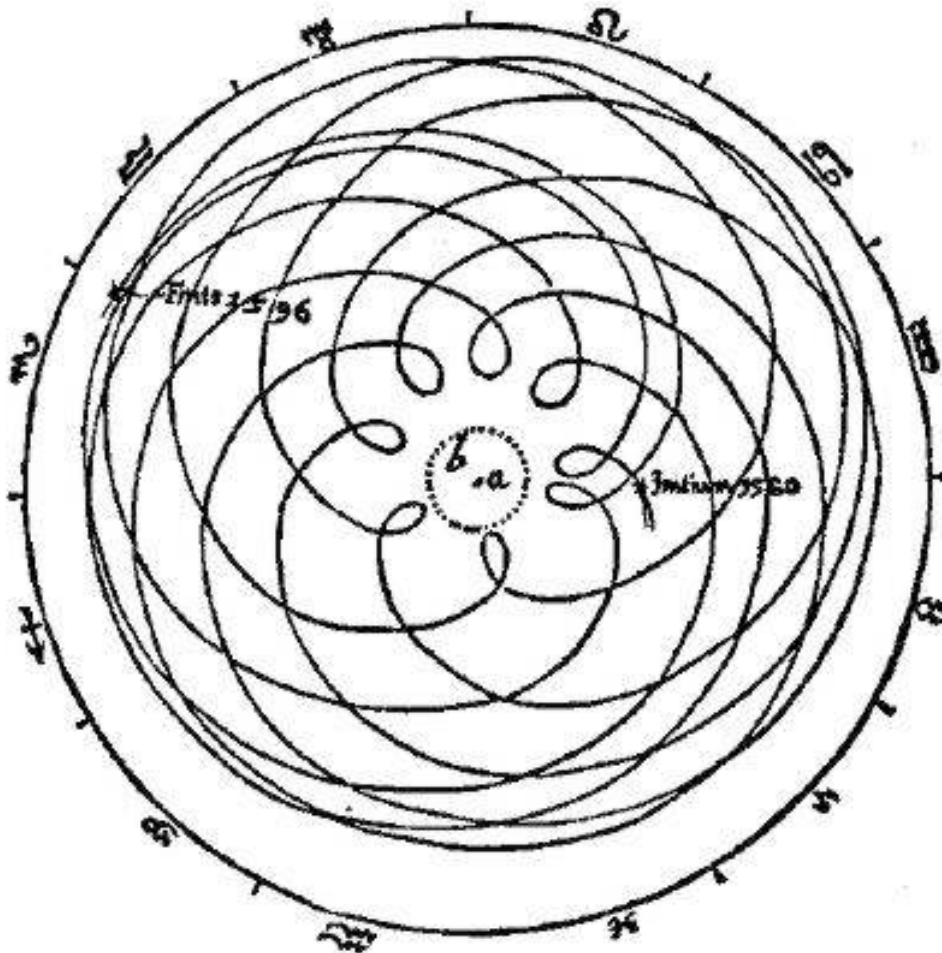


“**Almagest**” [only arabic translation survived] :
to explain **irregular motion** of planets introduces
epicycles:



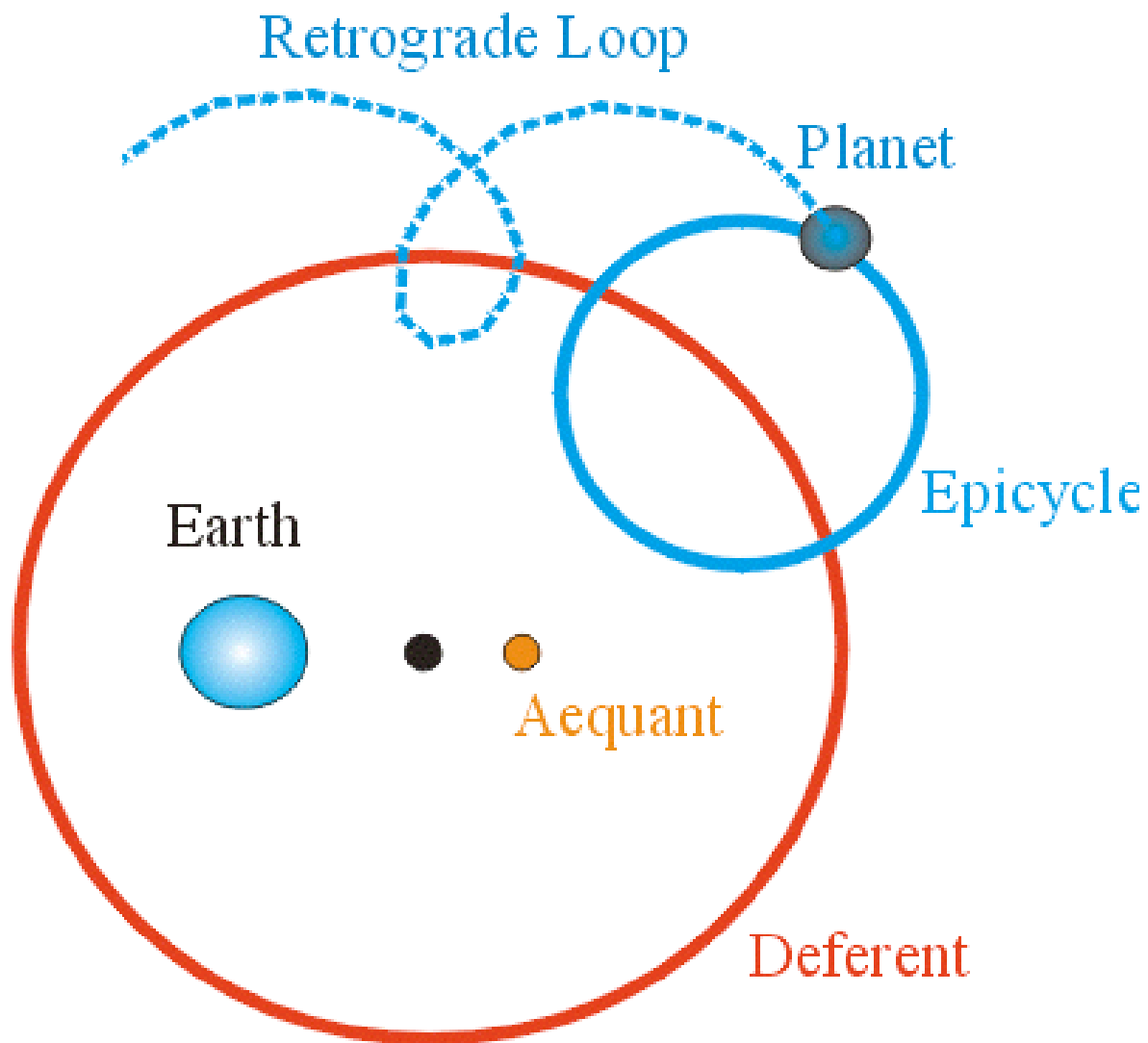
uniform motion on circle (“**epicycle**”) whose center moves on another circle “**deferent**”) [. . . + “**excentrics**” + “**equants**” . . .]

DE MOTIB. STELLÆ MARTIS



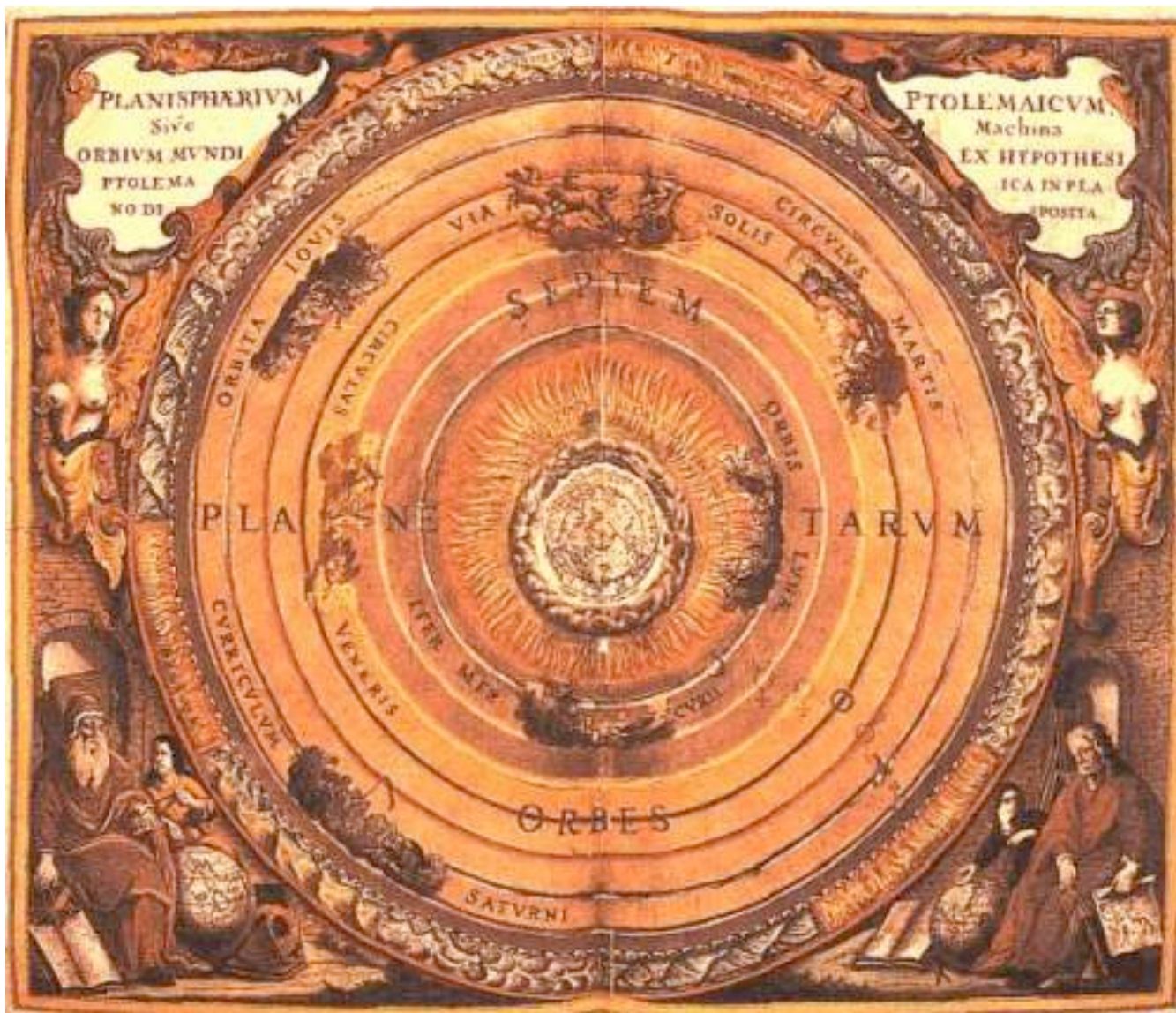
Motion of Mars [as observed by Tycho de Brahe (\approx 1600), taken from Kepler's book Astronomia Nova (1609)]

Explanation provided by **Ptolemaios**; composition of motions on perfect circles



VERY complicated !

Description of **7** celestial bodies (= Sun + Moon + 5 planets) require **39** circles



SATISFACTORY PREDICTIONS — DO **NOT**
 PROVIDE ANSWER TO QUESTION **WHY**

“The celestial bodies, by their **divine nature**, obey to **laws** which **differ** from those valid on Earth.”

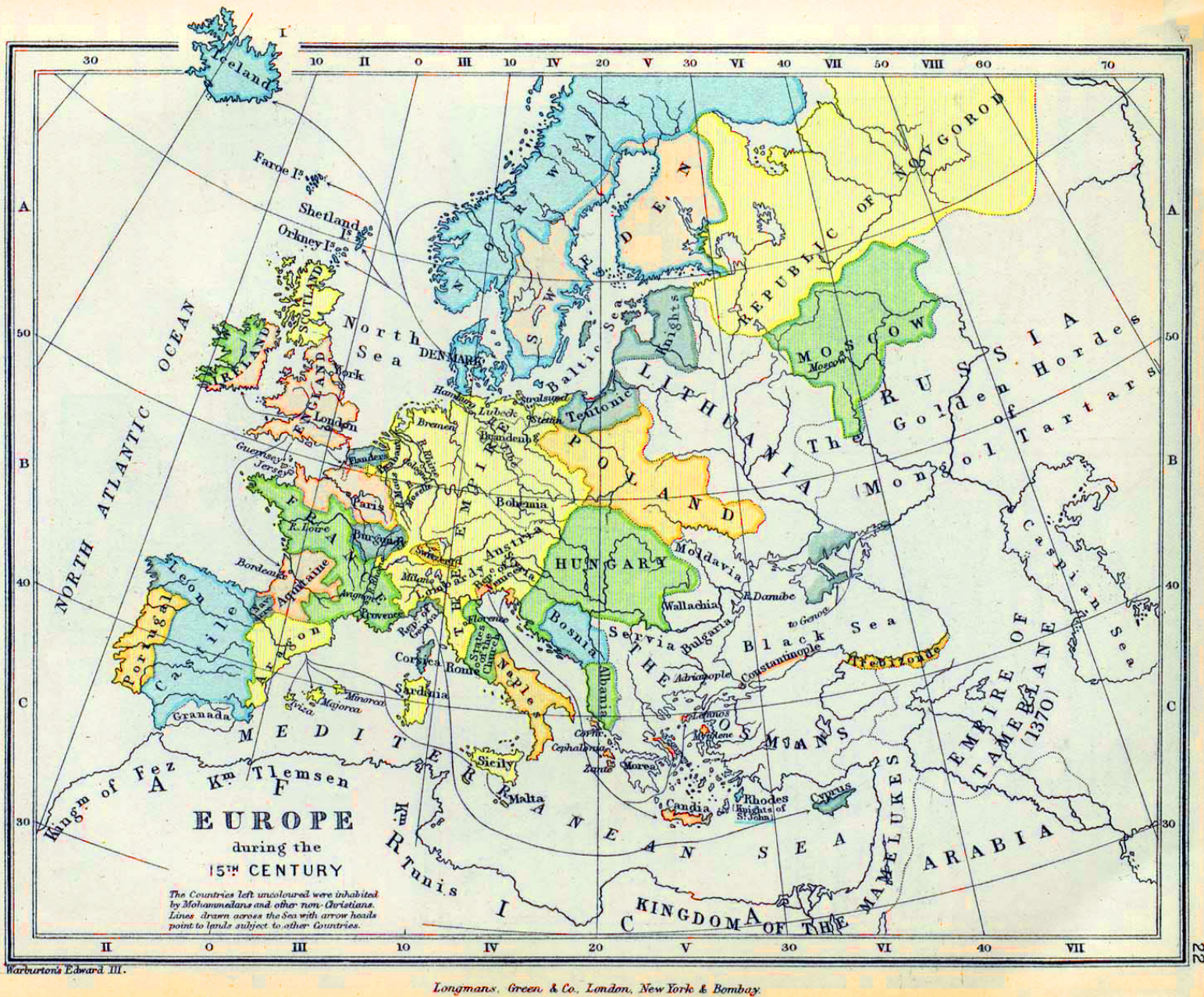
13th **ALFONSO EL SABIO** King of Castilia and Leon united in his court arabic and jewish scientists [and musicians]



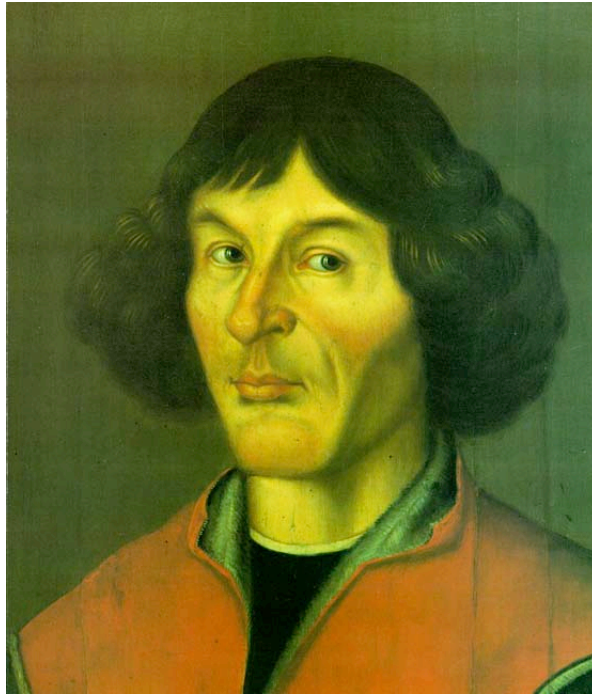
"If GOD had consulted me before undertaking the CREATION, I would have given Him better advice "

III. EUROPE: RENAISSANCE [“rebirth”]

After 1000 years resurrect ancient science and culture



Europe in the 15th century : Italy, Germany, France



COPERNICUS

(1473-1543)

Poland → Italy → Poland

DE REVOLUTIONIBUS ... 1543



Book 1: **simple** model : *The entire Universum (including the Earth) revolves uniformly around the **SUN** following **CIRCLES**.*



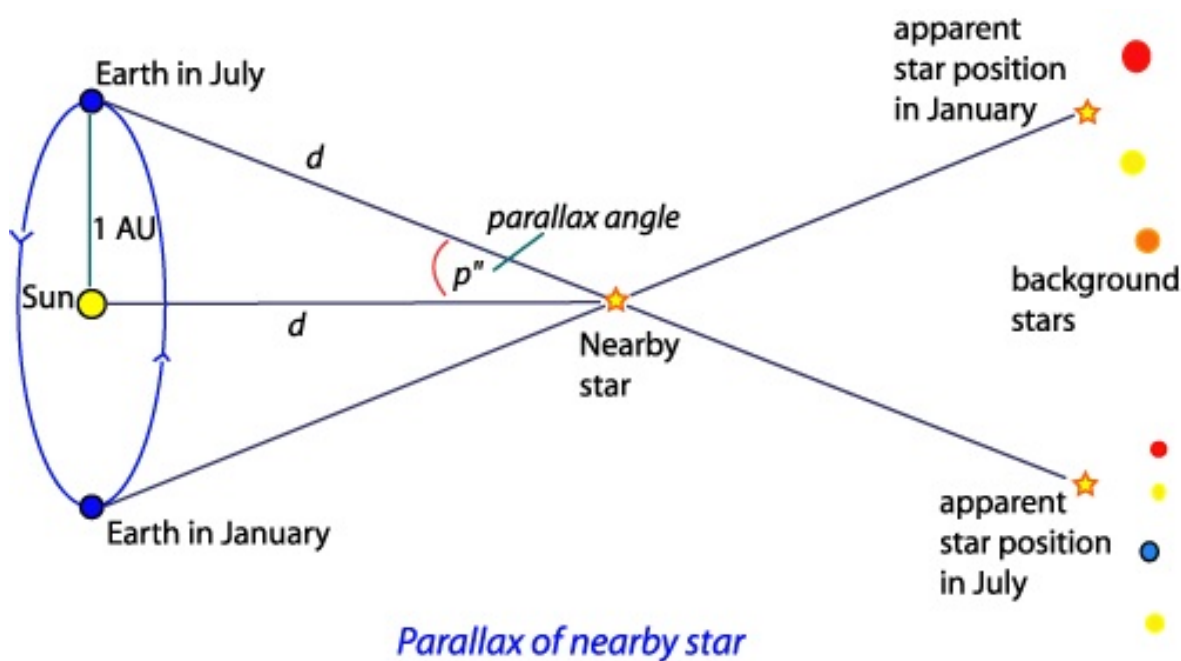
Does **NOT** claim to be **true** : (“mathematical hypotheses only” !)

SIMPLIFIED SYSTEM of COPERNIC EQUIVALENT
to Ptolemaios' !!! \Rightarrow predictions unprecises \Rightarrow
“corrections”

Books 2-6 : re-introduces epicycles, deferents
excentrics,...

Earth: 3 circles: + other planets \Rightarrow require
total of 34 circles !

- Sun does NOT play distinguished physical rôle
- opponents criticize: NO PARALLAX



— observed by Bessel in 1838 using powerful
telescope. 61 Cygni had a parallax of 0.314 arc-
seconds \Rightarrow allows to determine distance of star.
[Copernicus' precision: 8 seconds]



Europe at 1600

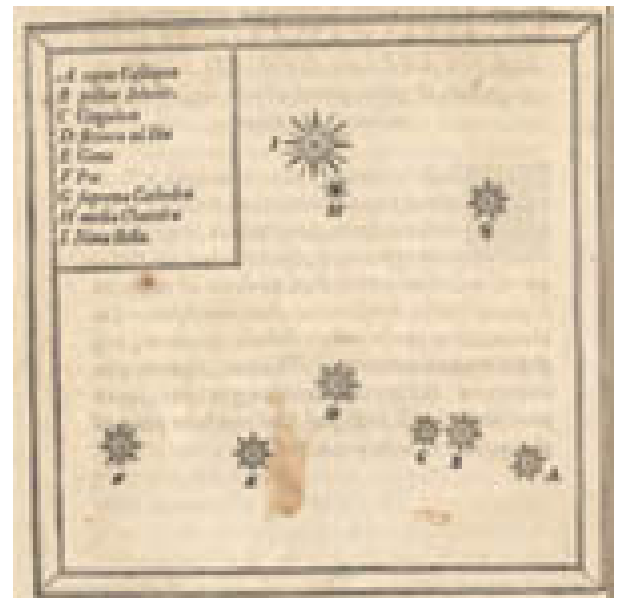
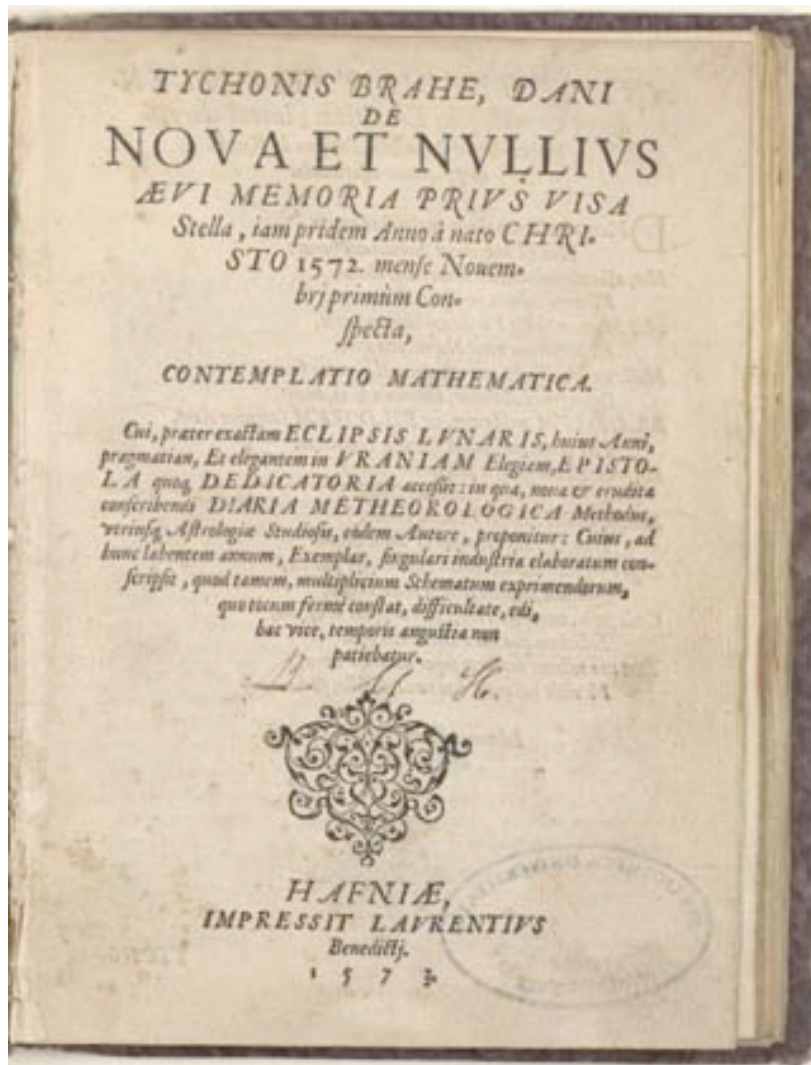


TYCHO DE BRAHE

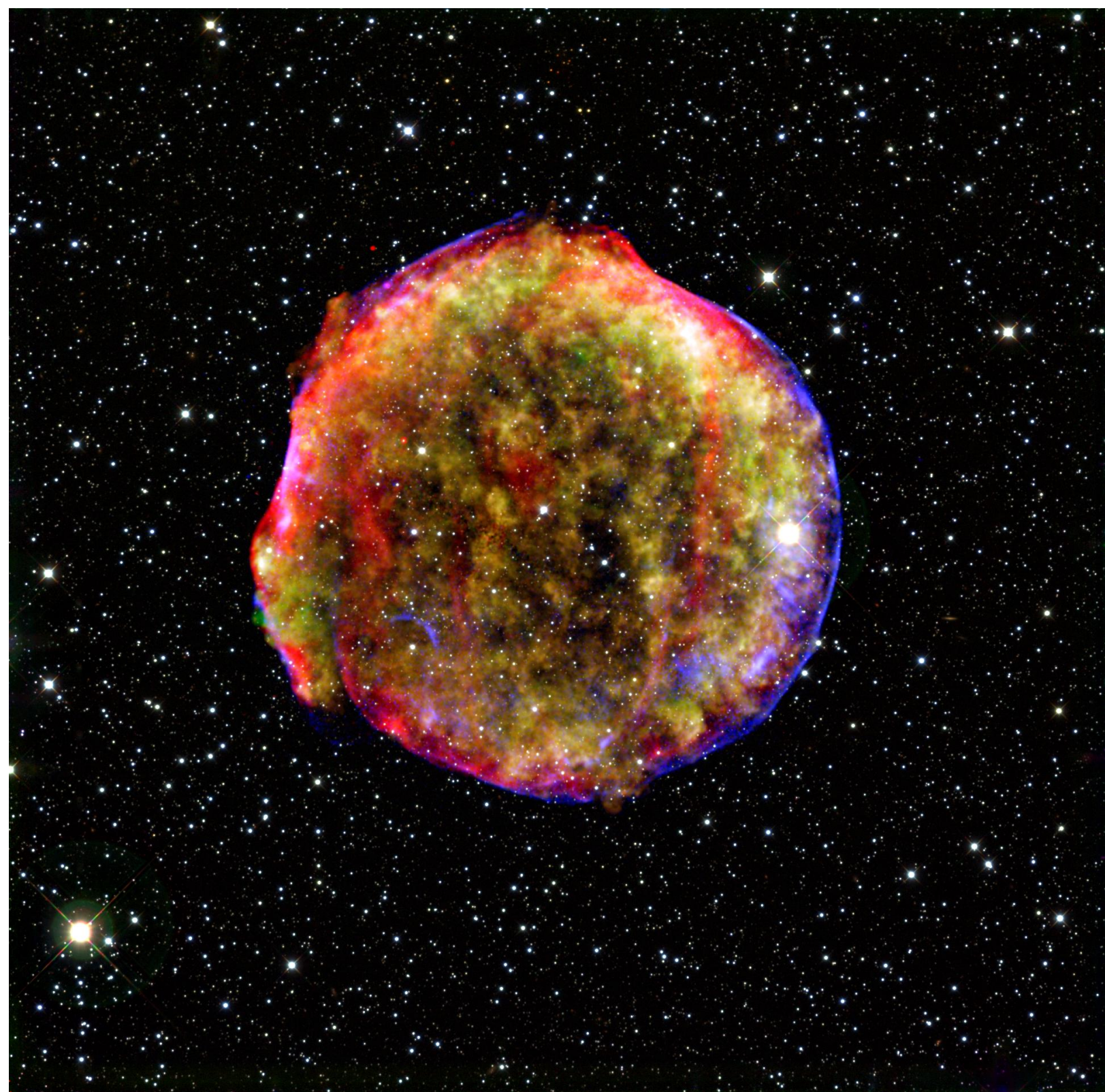
Danish aristocrat (1546-1601).

Nose cut in course of “mathematical competition”

1572 : Observes new star in Cassiopeia constellation



In fact **supernova SN 1572** found again



1577 : Comet



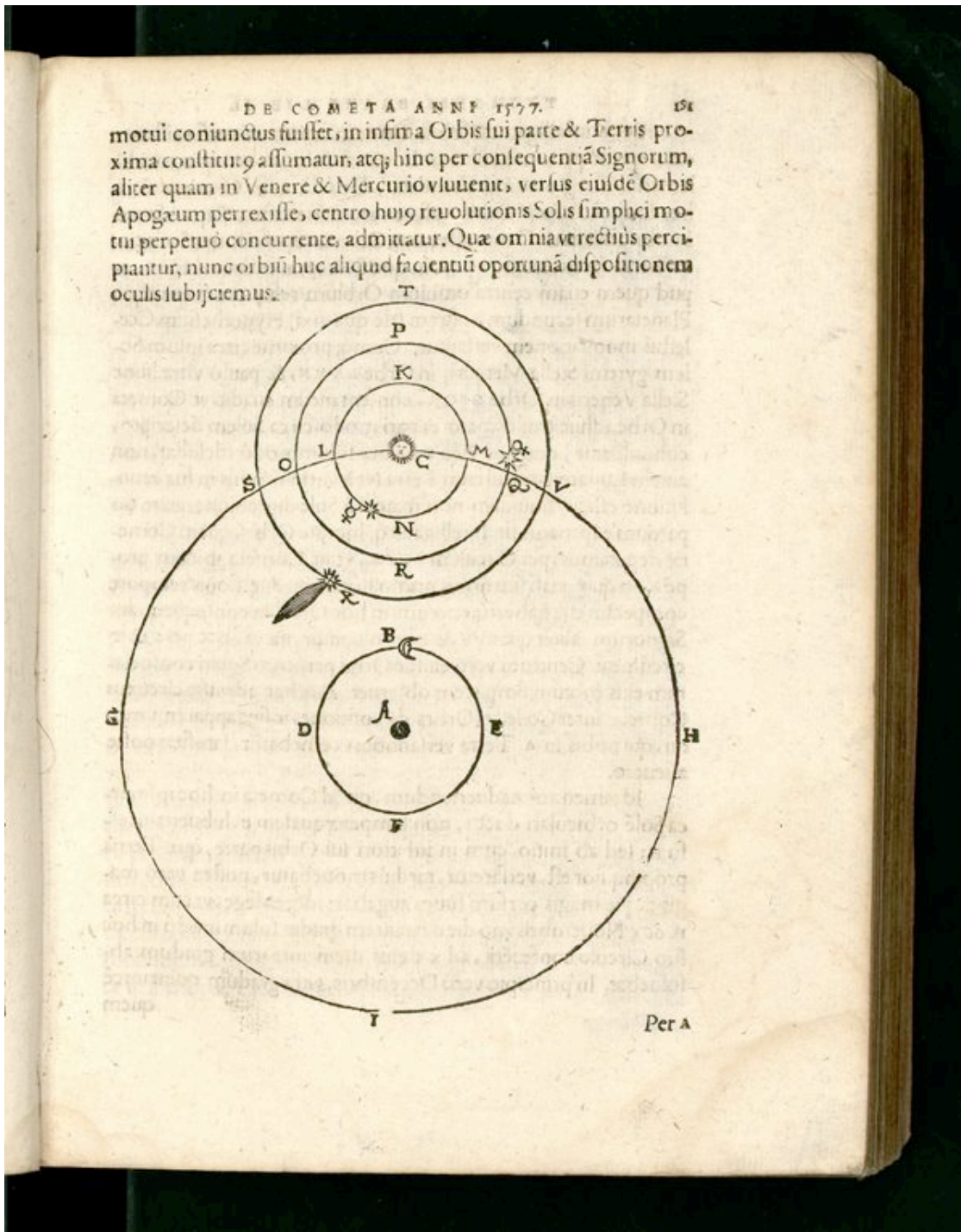
German newspaper report



also seen in **Istanbul** (Turkey)

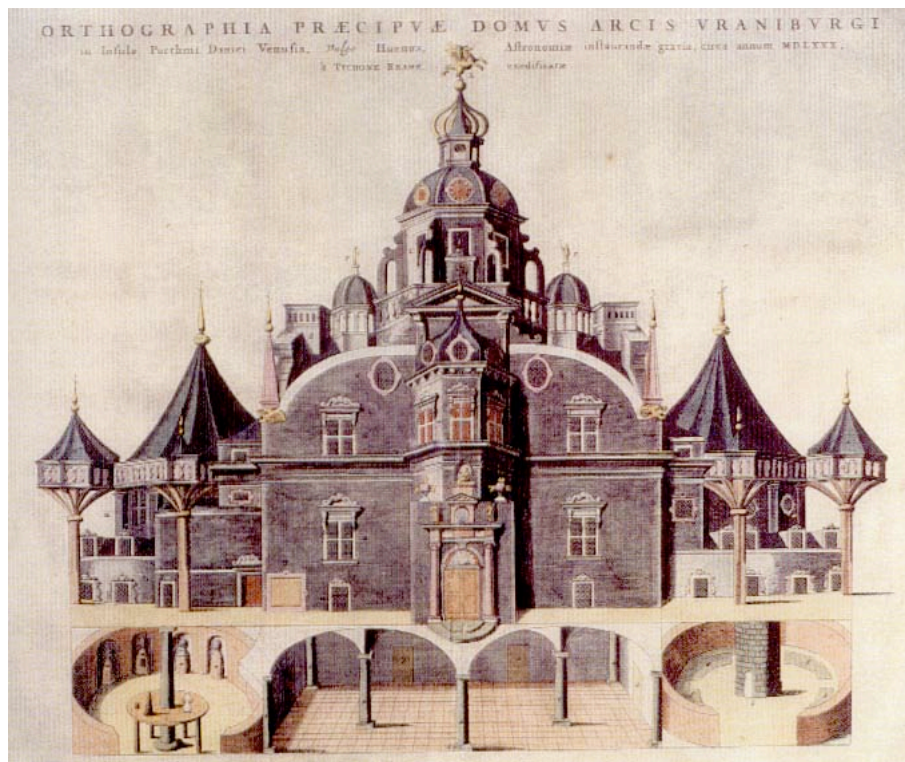
Tycho : Distance from the Earth is **at least 6 times** superior to that of Earth - Moon :

⇒ **NOT** “sublunar phenomenon”.



His discoveries shake medieval doctrine of **immuability** of **“superlunar sky”** [=beyond the Moon].

Uraniborg astronomical observatory (Copenhagen),





Highest precision ever attained without telescope:
 2'-5' (thumb: 30')

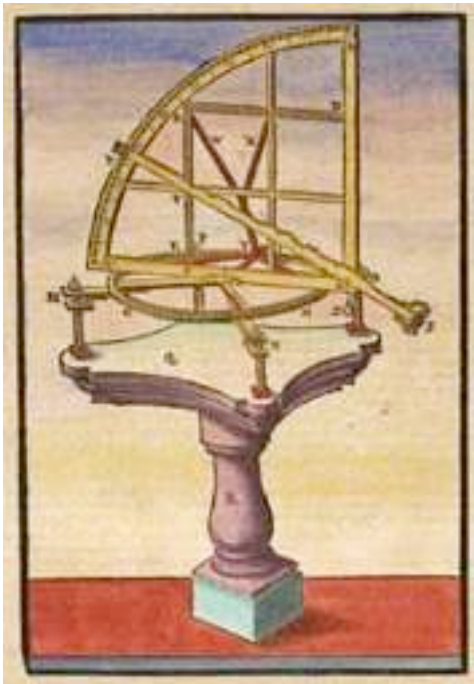
Plans and makes construct sophisticated astro-



nomical instruments

Only surviving instruments in Beijing Observatory !





Celestial globe