Scientific Revolution

Greco-Roman World

The School of Athens - Raphael

Nature

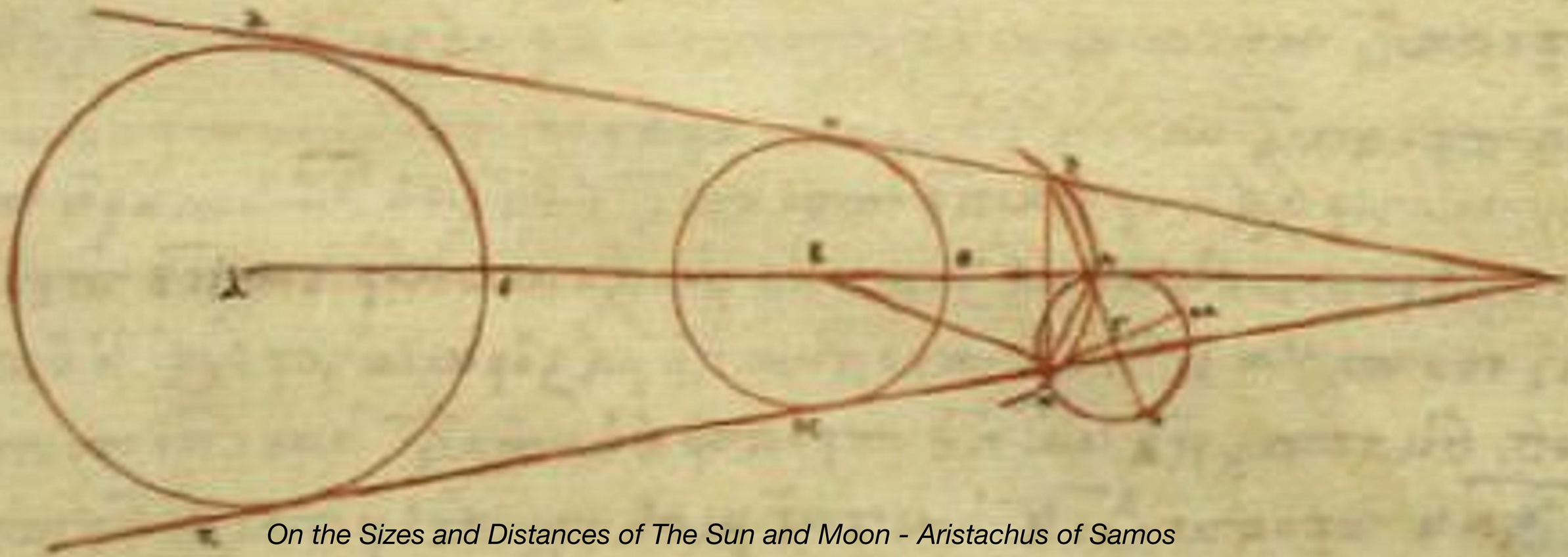
philosophia

φιλοσοφία

philos + sophia

philos + **sophia**

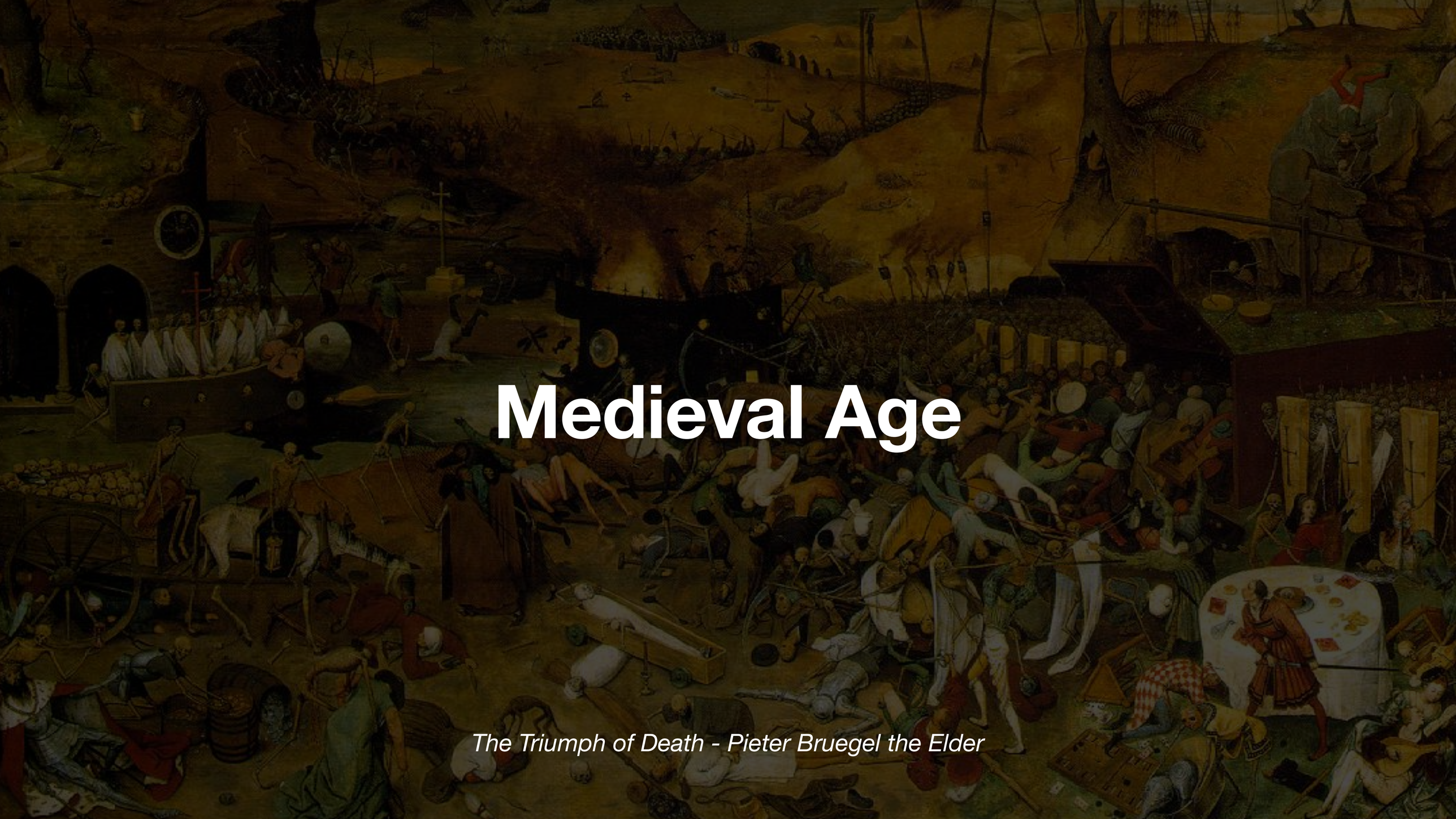
Love *Wisdom*



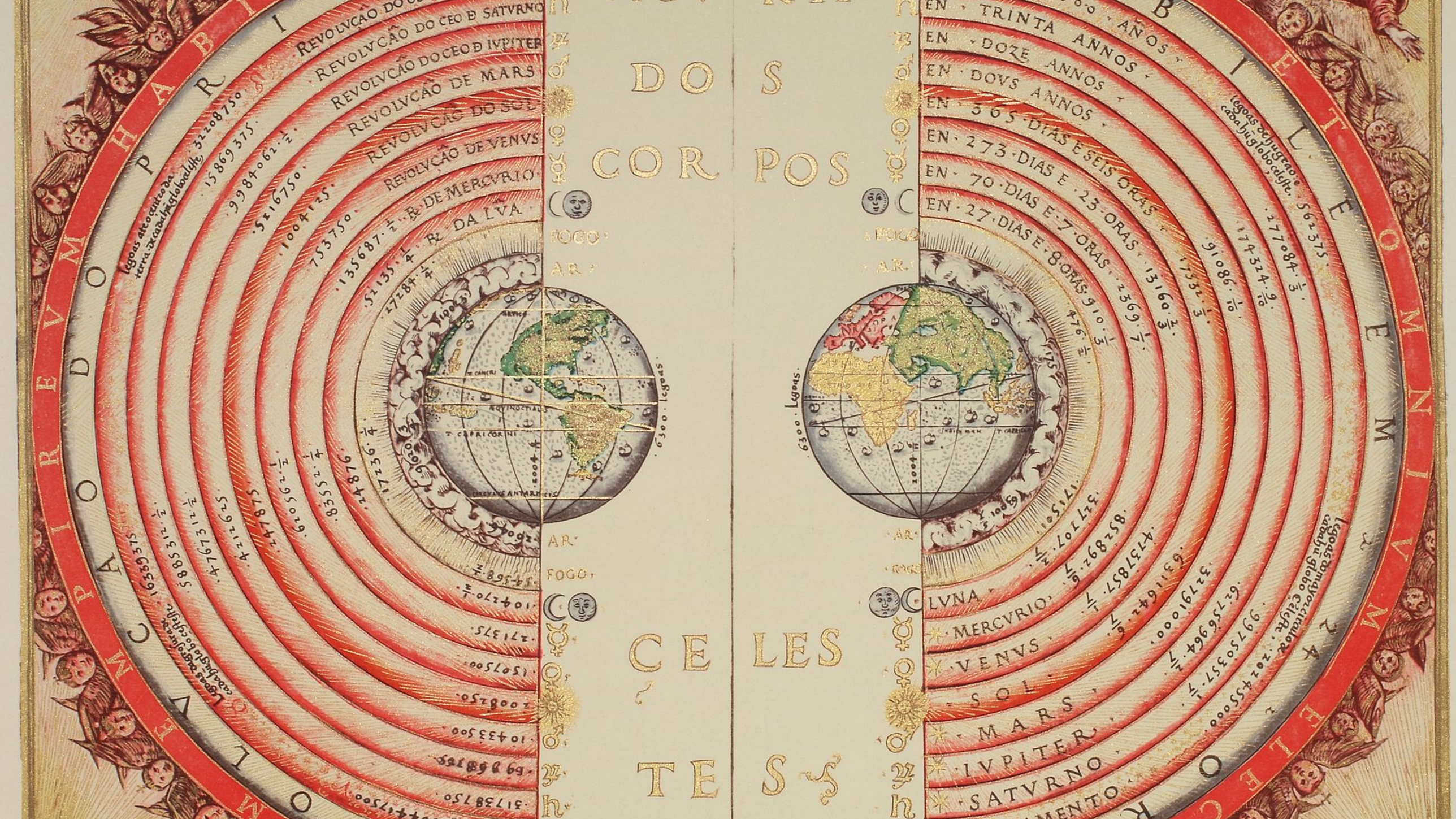
On the Sizes and Distances of The Sun and Moon - Aristachus of Samos

Heliocentric

Medieval Age



The Triumph of Death - Pieter Bruegel the Elder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REVOLVÇÃO DO CEO D SATVRNO
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REVOLVÇÃO DE MARS
REVOLVÇÃO DO SOL
REVOLVÇÃO DE VENVS
REVOLVÇÃO DE MERCVRIO
R. DA LVA
EN TRINTA ANNOS
EN DOZE ANNOS
EN DOVS ANNOS
EN 365 DIAS E SEIS ORAS
EN 273 DIAS E 23 ORAS
EN 70 DIAS E 7 ORAS
EN 27 DIAS E 8 ORAS
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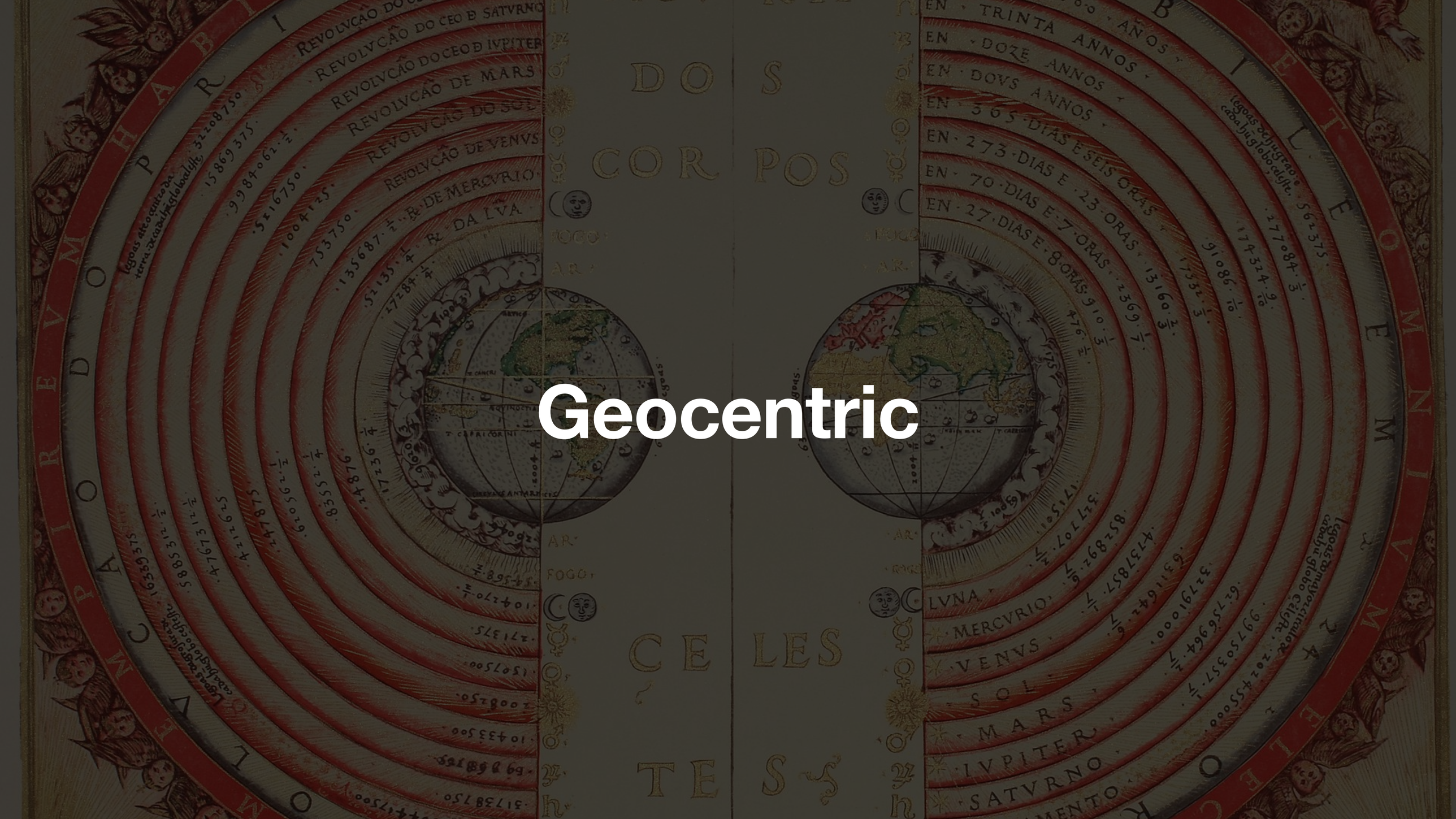
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SATVRNO
EN TRINTA ANNOS
EN DOZE ANNOS
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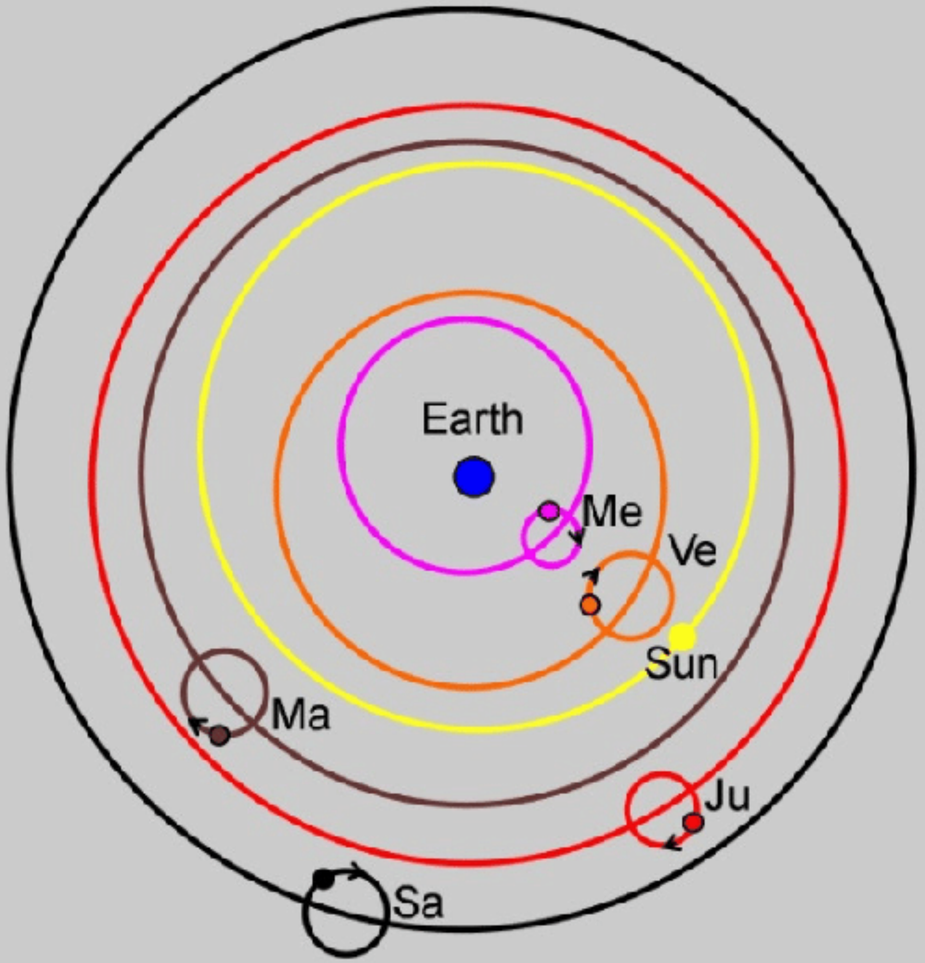
EN 273 DIAS E 23 ORAS
EN 70 DIAS E 7 ORAS
EN 27 DIAS E 8 ORAS

Geocentric

Retrograde Motion



Epicycles

“I have declared infinite worlds to exist beside this our earth.
It would not be worthy of God to manifest Himself in less than an infinite universe.”

Giordano Bruno

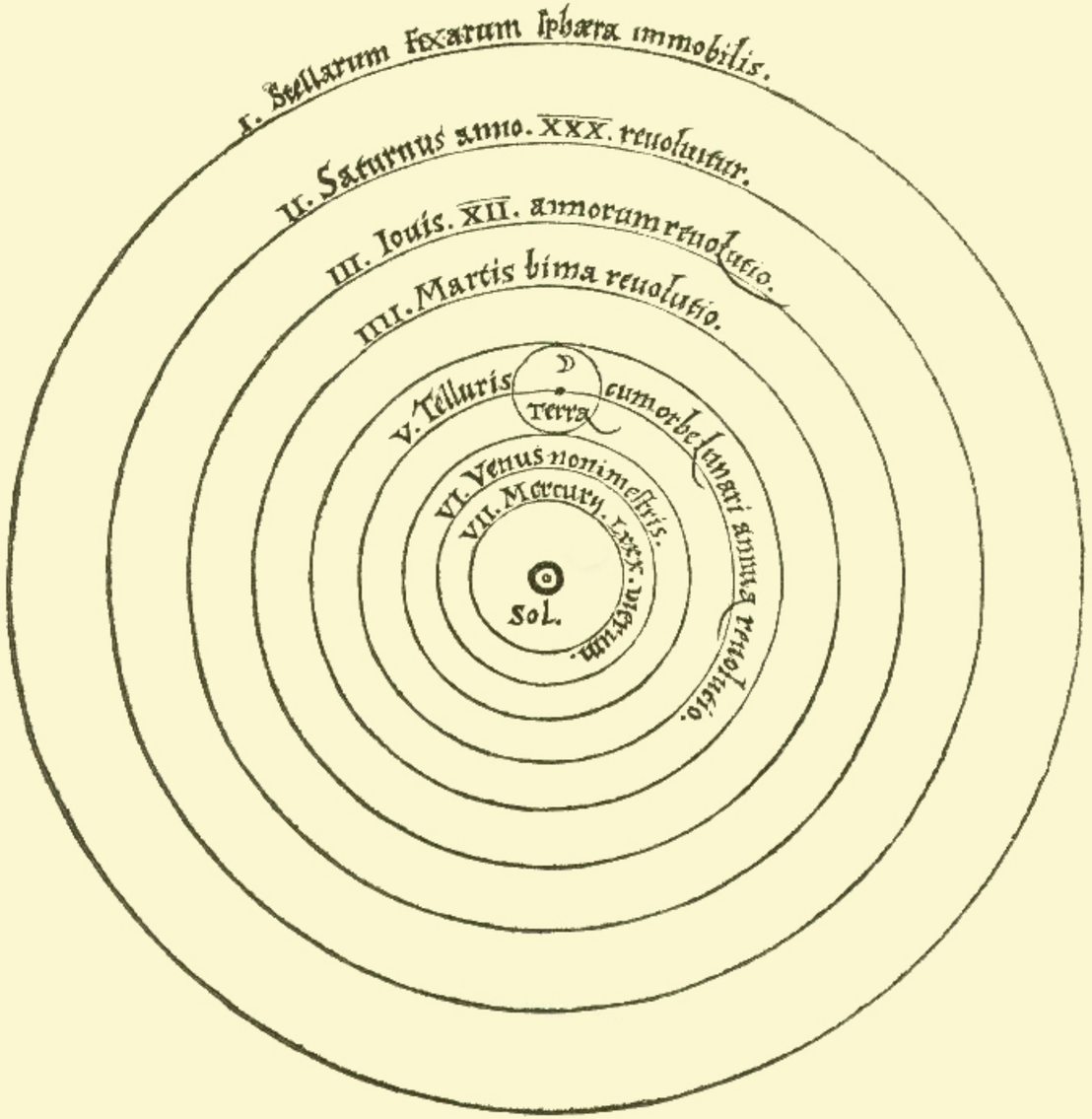
GIORDANO
BRUNO

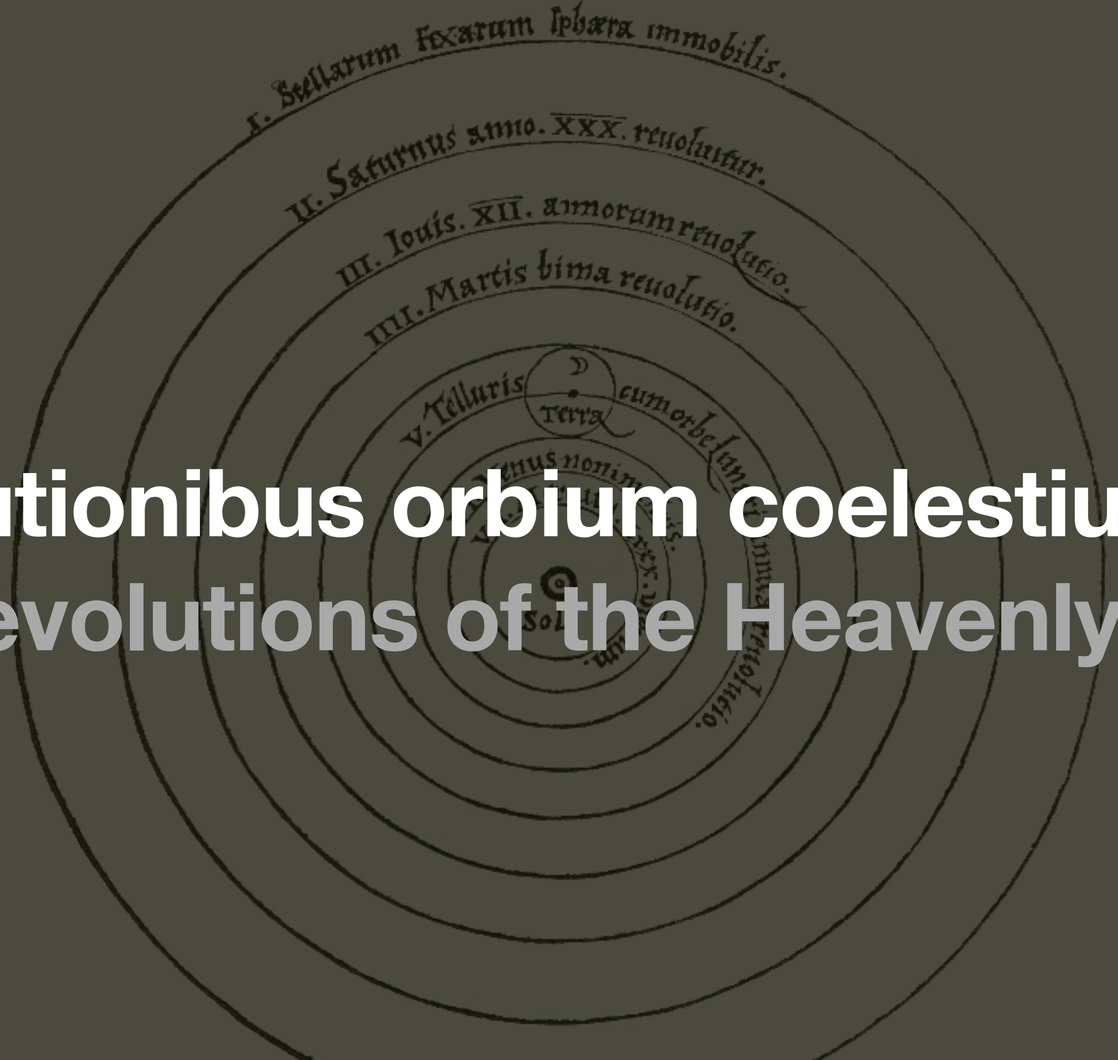
Potsdamer Platz - Germany

Renaissance

The Creation of Adam - Michelangelo

Nicholaus Copernicus (1473-1543)
Astronom Kopernik, czyli rozmowa z Bogiem - Jan Matejko

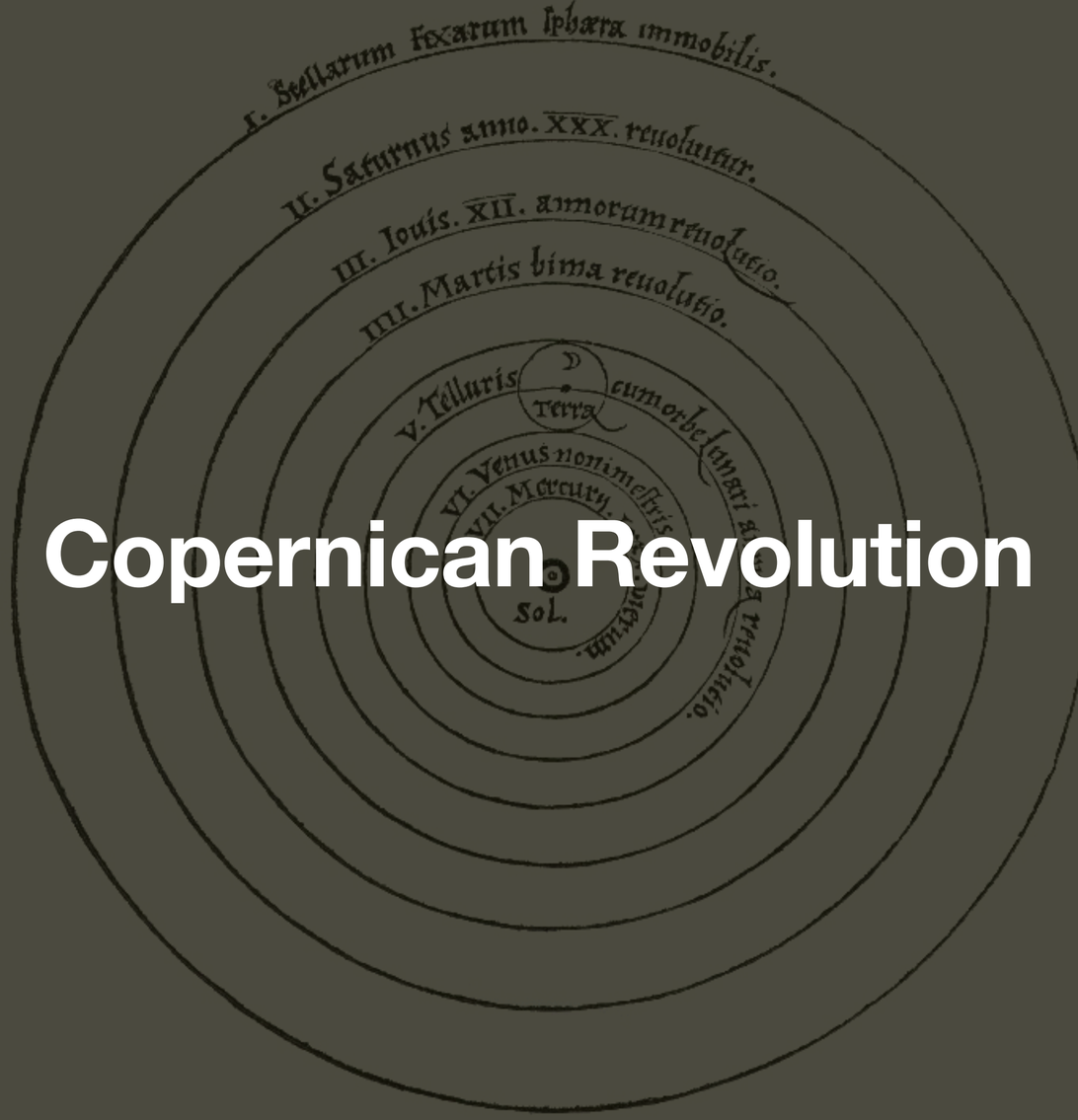

I. Stellarum fixarum sphæra immobilis.
II. Saturnus anno. XXX. revoluitur.
III. Iouis. XII. annorum revolutio.
IIII. Martis bima revolutio.
V. Telluris
☽
Terra
cum orbe lunari annua revolutio.
VI. Venus nonimestris.
VII. Mercurius. LXXX. dierum.
Sol.



De revolutionibus orbium coelestium (1543)

On the Revolutions of the Heavenly Spheres

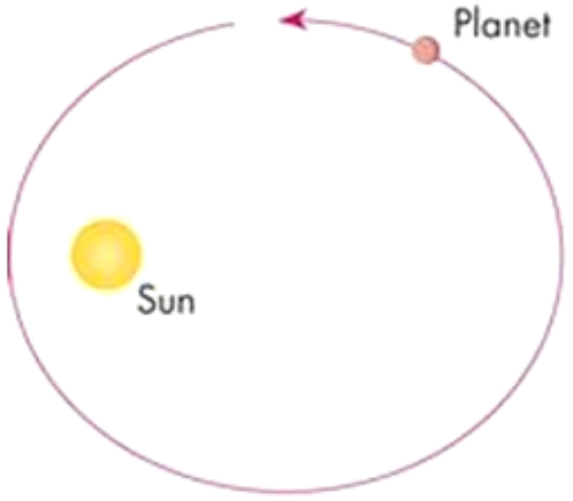
Nicholaus Copernicus



Copernican Revolution

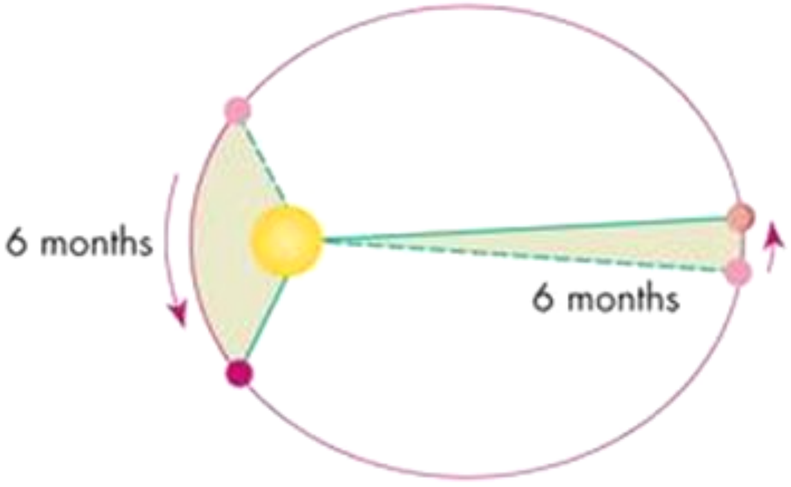
Johannes Kepler (1571-1630)

Kepler's 3 Laws of Planetary Motion



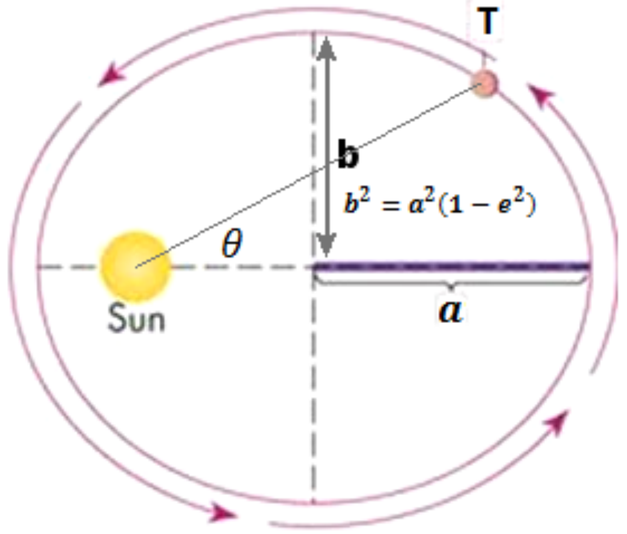
(1)

The orbits are ellipses



(2)

Equal areas in equal time



(3)

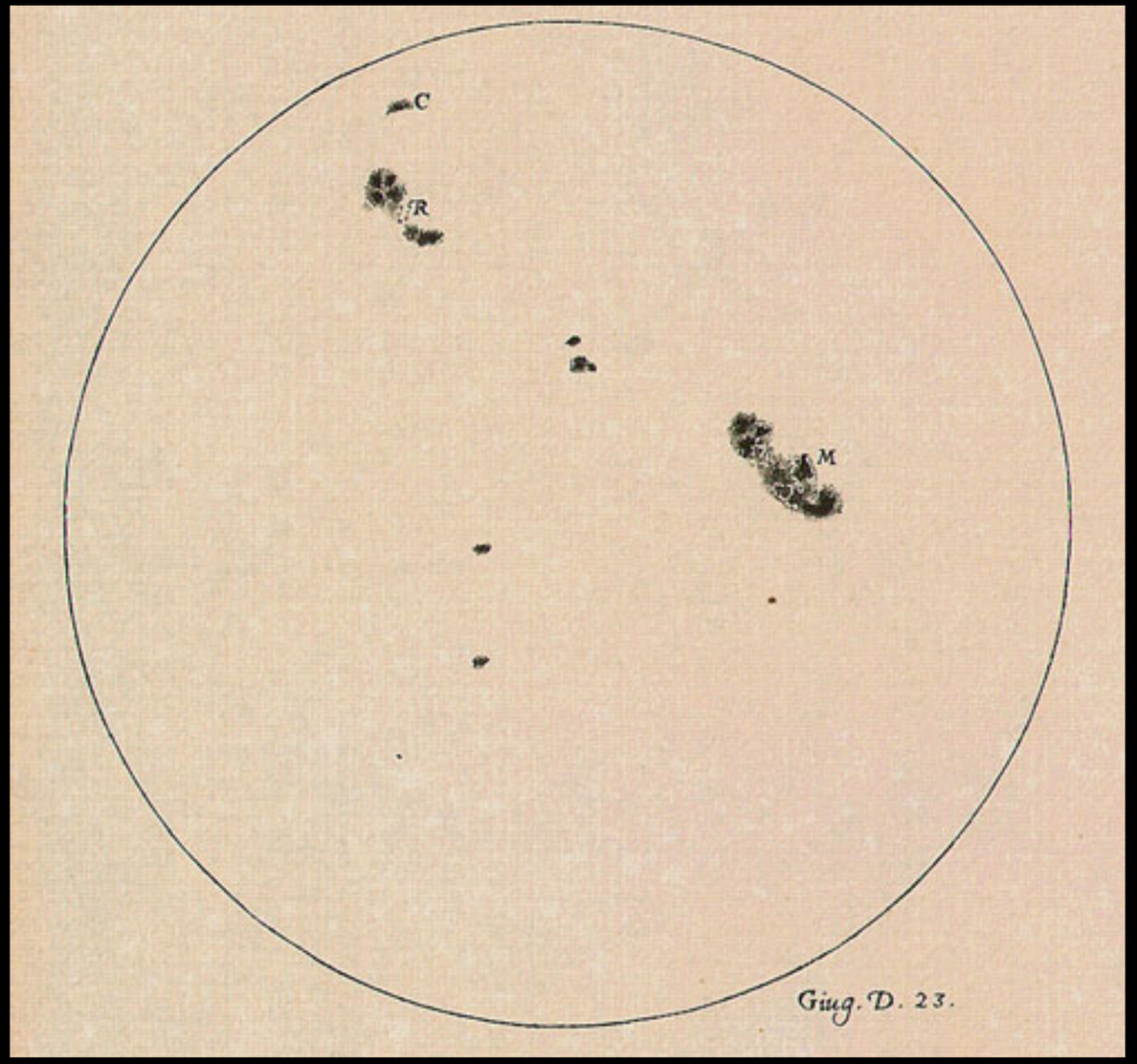
$T^2 \propto a^3$

T = time to complete orbit

a = semi-major axis

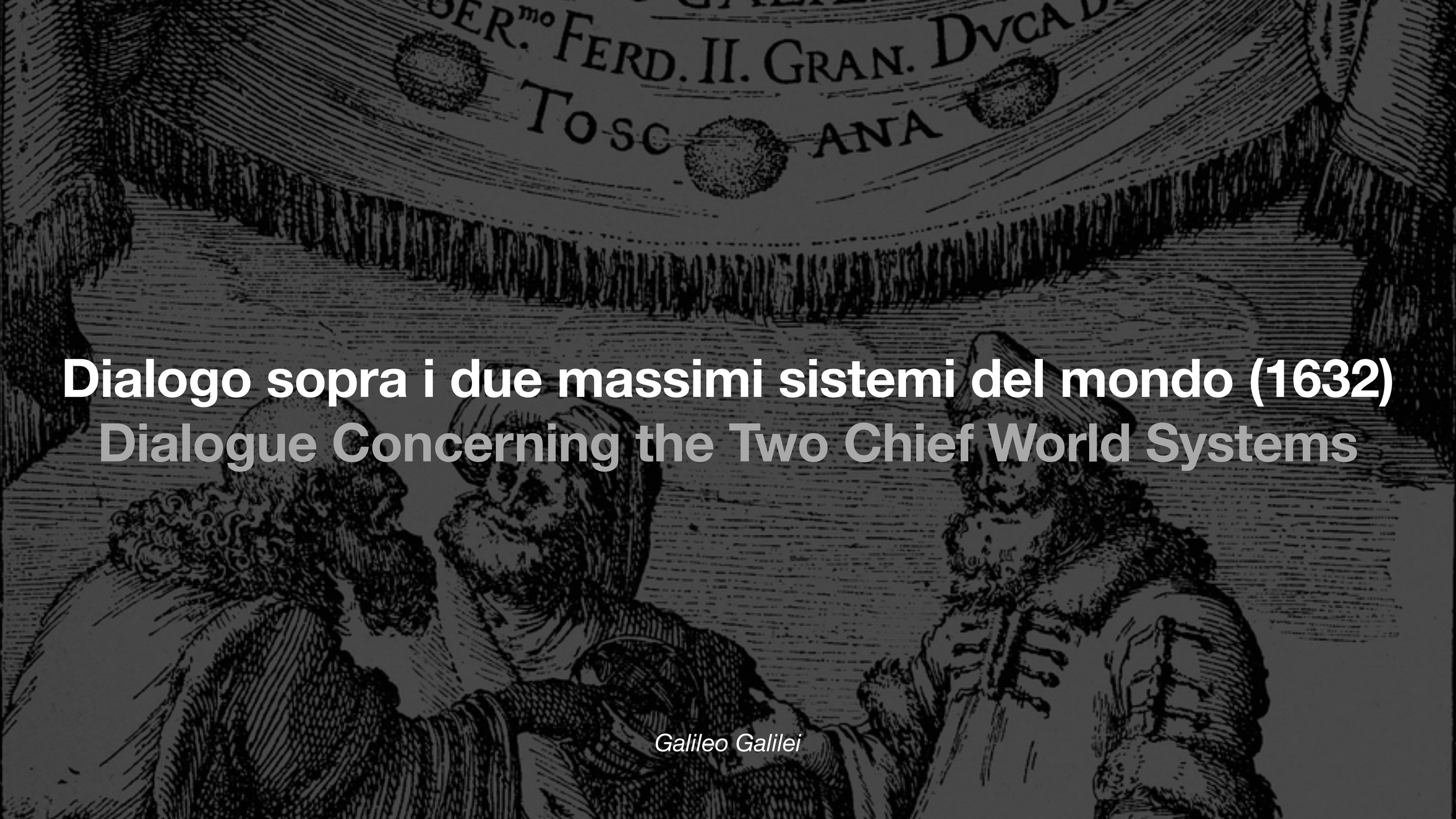
First telescope was built -1609

Galilean Moons



Galileo's Sunspots

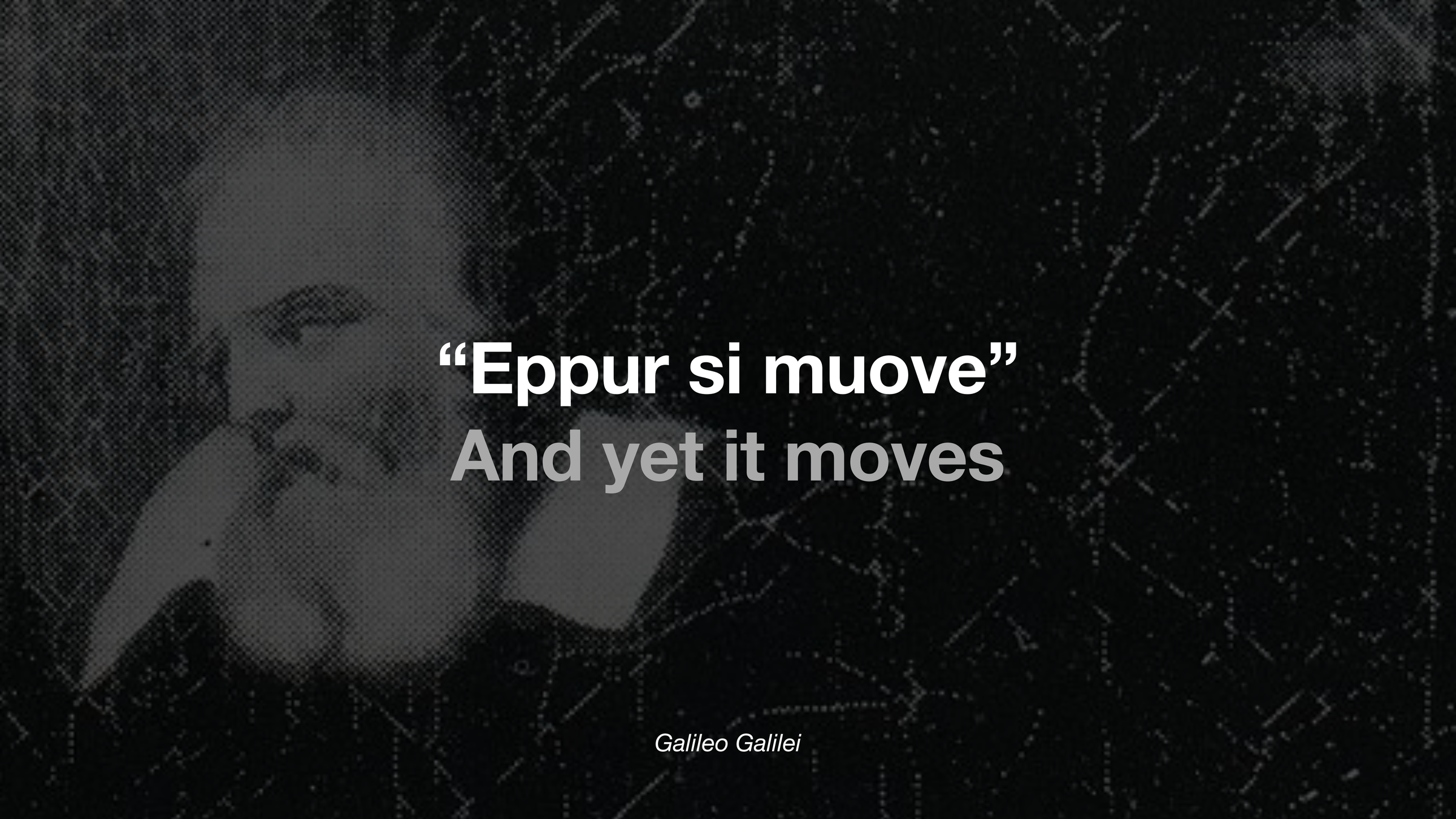
Galileo facing the Roman Inquisition - Cristiano Banti



Dialogo sopra i due massimi sistemi del mondo (1632)

Dialogue Concerning the Two Chief World Systems

Galileo Galilei


“Eppur si muove”
And yet it moves
Galileo Galilei

Galileo Galilei

Died 8 January 1642

Isaac Newton

Born 25 December 1642

ISAACUS NEWTON EQ. AUR. ÆT. 83.

I Vanderbank pinxit 1725 — Geo. Vertue Sculpsit 1726

PHILOSOPHIÆ NATURALIS PRINCIPIA MATHEMATICA.

AUCTORE

ISAACO NEWTONO, Eq. Aur.

Editio tertia aucta & emendata.

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Apud Guil. & Jon. Innys, Regiæ Societatis typographos.

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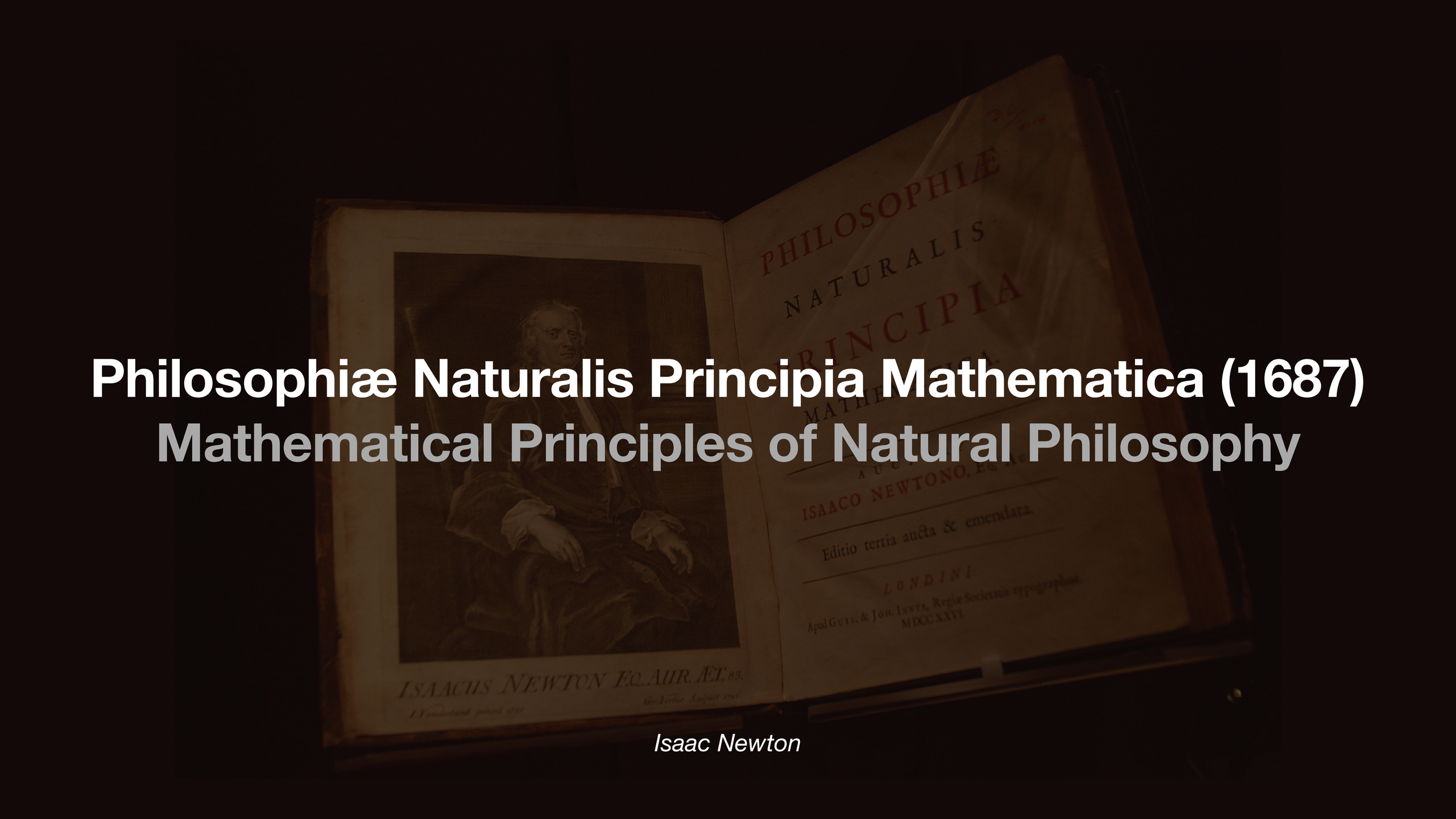


Philosophiæ Naturalis Principia Mathematica (1687)

Mathematical Principles of Natural Philosophy

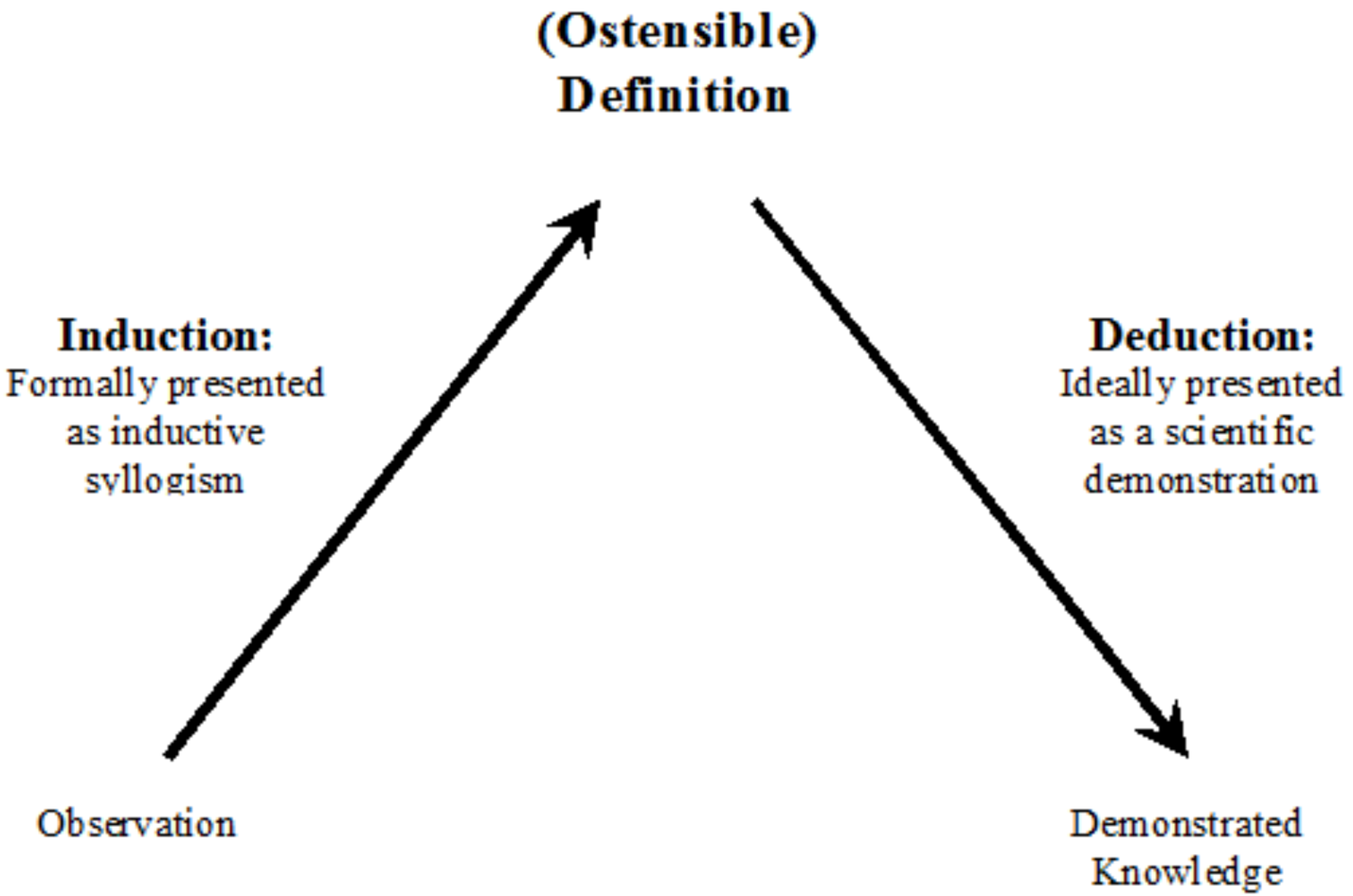
Isaac Newton

Epistemology

Epistemology

the theory of knowledge, especially with regard to its methods, validity, and scope.

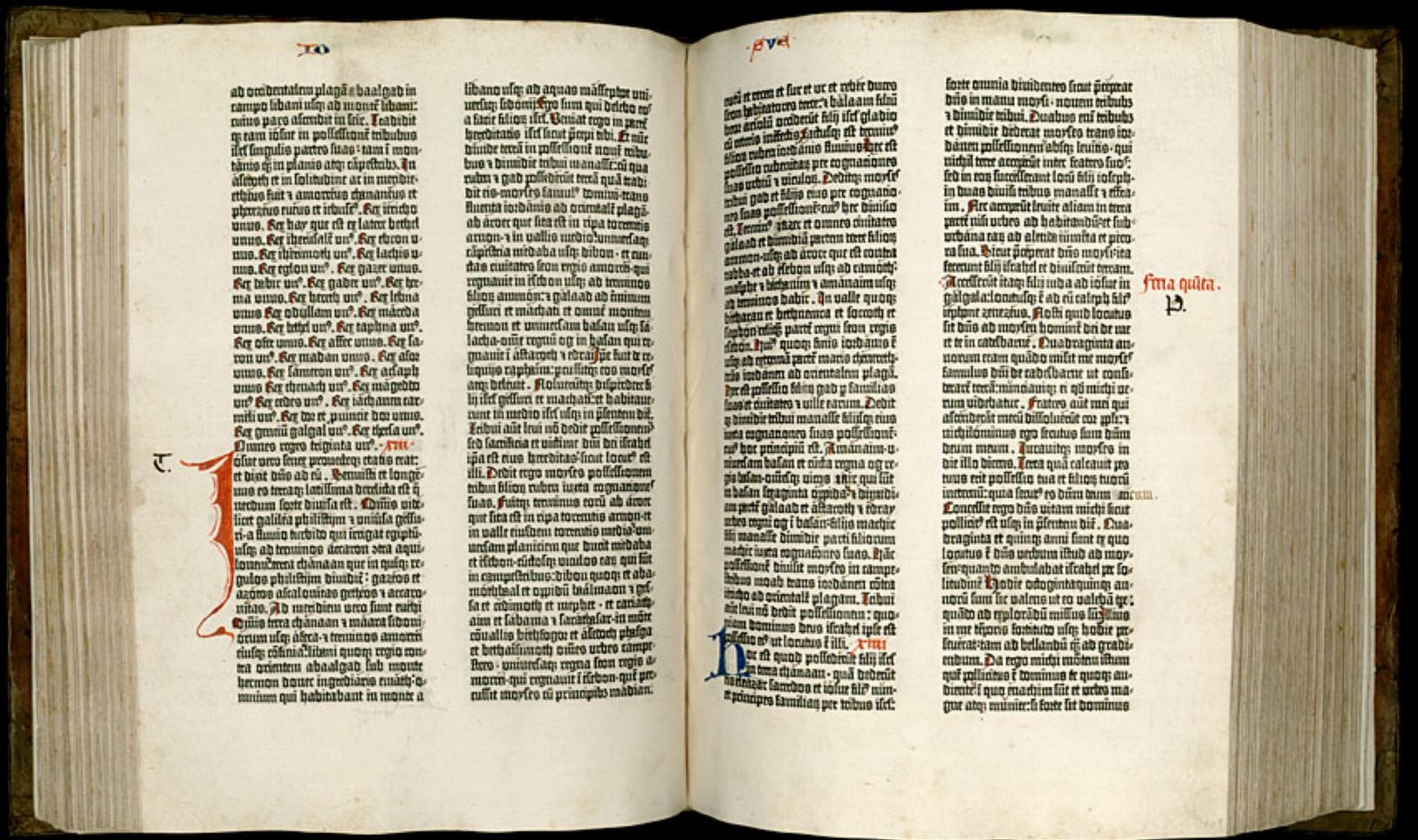
Aristotelian’s Method



Aristotelian's Method

Gutenberg Press

Johannes Gutenberg, 1904 reconstruction



ad occidentalem plagã baalgad in
campo libani usq; ad montẽ libani:
cuius partes obtenuit in fine. Tradidit
q; eam iosue in possessionẽ tribubus
iuxta singulas partes suas: tam ĩ mon-
tanis q; in planis atq; campestribus. In
aseneth et in solitudine ac in meridie
etthei fuit r amorrheus chananeus et
pherezeus iebuseus et iebuseus. Rex iericho
unus. Rex hay qui est e latere bethel
unus. Rex iherusalem unus. Rex hebron u-
nus. Rex iarmoth unus. Rex lachis u-
nus. Rex eglon unus. Rex gazer unus.
Rex debir unus. Rex gader unus. Rex her-
ma unus. Rex arath unus. Rex lebna
unus Rex odollam unus. Rex macheda
unus. Rex bethel unus. Rex thaphua unus.
Rex opher unus. Rex affec unus. Rex sa-
ron unus. Rex madon unus. Rex asor
unus. Rex semeron unus. Rex acsaph
unus Rex thenach unus. Rex mageddo
unus Rex cedes unus. Rex iachanam car-
mili unus. Rex dor et pumeir dor unus.
Rex gentium galgal unus. Rex thersa unus.
Omnes regi triginta unus. xiii

Ista vero sunt que remanserũt gentes
et dixit dñs ad iesu. Senuisti et longæ-
vus es terraq; latissima possessa est q;
nondum sorte diuisa est. Omnis vide-
licet galilea philistiim r omnia gessu-
ri-a fluuio turbido qui irrigat egyptũ
usq; ad terminos accaron vers aqui-
lonem ĩputata chananæa que in quinq; re-
gulos philistiim diuidit: gazeos et
azotos ascalonitas getheos r accaro-
nitas. Ad meridiem vero sunt euæi
Omnis terra chananæa r maarathi sidoni
orum usq; afeca-r terminos amorrei
eiusq; cõfinia libani quoq; regio con-
tra orientem abaalgad sub monte
hermon donec ingrediaris emath: o-
mnium qui habitabant in monte a

libano usq; ad aquas massephot uni-
uersi sidonii. Ego sum qui delebo eos
a facie filiorũ israel. Verumtamen tu im pare
hereditatis illi sortẽ super eos.
diuide terrã in possessionẽ nouẽ tribu-
bus r dimidie tribui manasse: cũ qua
rubẽ r gad possederũt terrã quã tradi
dit eis-moyses famul⁹ domini-trans
fluuiũ iordanis ad orientalẽ plagã.
ad deser que sita est in ripa torrentis
arnon-r in vallis medio torrentis
riphthia medaba usq; dibon. et om-
nes ciuitates eius regio amorrei qui
regnauit in esebon usq; ad terminos
filioꝝ ammon: r galaad ad finium
gessuri et machati et omne montem
hermon et vniuersam basan usq; sa-
lacha-omne regnũ og in basan qui re-
gnauit i astaroth r edrai ipse fuit de re-
liquiis raphaim: percussitq; eos moyses
atq; deleuit. Noluerũtq; dispredere fi-
lij iesu gessuri et machati: et habitaue-
runt in medio iesu usq; in presentem diẽ.
Tribui aũt leui nõ dedit possessionem
sed sacrificia et victimas dñi dei israel
ipsa est eius hereditas-sicut locutus est
illi. Dedit ergo moyses possessionem
tribui filiorũ ruben iuxta cognationes
suas. Fuitq; terminus eorũ ab aroer
que sita est in ripa torrentis arnon-et
in valle eiusdem torrentis medioq; om-
nem planitiem que datur medaba
et esebon-usq; usq; ad eos qui sunt
in campestribus: dibon quoq; et aba-
mothbaal et oppidũ baalmaon r gel-
sa et casamoth et mephet - et cariath-
aim et sabama r sarathsahar-in mõte
cõuallis bethfogor et asedoth phasga
et bethasimoth omnes urbes campe-
stres - uniuersam regnũ seon regis a-
morrei-qui regnauit i esebon-quẽ per-
cussit moyses cũ principibus madian.

ui et recem et sur et ur et rebee duces
seon habitatores terre. r balaam filiũ
beor ariolũ occiderũt filij israel gladio
cũ ceteris interfectis. Factusq; est dominus
filius ruben iordanis fluuius-hec est
possessio rubenitas per cognationes
suas urbes r vicos. Deditq; moyses
tribui gad et filijs eius per cognatio-
nes suas possessionẽ-eas hec diuisio
est. Termin⁹ iazer et omnes ciuitates
galaad et dimidiã partem terre filioꝝ
ammon-usq; ad aroer que est contra
rabba-et ab esebon usq; ad ramoth-
masphe r betheanim r manaaim usq;
ad terminos dabir. In valle quoq;
betharan et bethnamra et socoth et
saphon reliquã partẽ regni seon regis
esebon. Iordanes quoq; finis iordanis ẽ
usq; ad extremã partẽ maris chenereth-
trans iordanem ad orientalem plagã.
hec est possessio filioꝝ gad p familias
suas et ciuitates r ville earum. Dedit
q; dimidie tribui manasse filijsq; eius
iuxta cognationes suas possessionẽ
eis hec principiũ est. Amanaim u-
niuersam basan et cuncta regna og re-
gis basan-omnesq; vicos iair qui sunt
in basan sexaginta oppida: r dimidi-
am partẽ galaad et astaroth r edray
urbes regni og i basan-filijs machir
filij manasse dimidie parti filiorum
machir iuxta cognationes suas. Hec
possessionẽ diuisit moyses in campe-
stribus moab trans iordanem contra
iericho ad orientalẽ plagam. Tribui
aũt leui nõ dedit possessionem: quo-
modo locutus dominus deus israel ipse est
possessio eius ut locutus ẽ illi. xiiii

Hec est quod possederũt filij israel
in terra chanaan - quã dederũt
eis eleazar sacerdos et iosue filius nun
et principes familiarũ per tribus filio-

sorte omnia diuidentes sicut precepit
dñs in manu moysi - nouem tribubus
r dimidie tribui. Duabus enim tribubus
et dimidie dederat moyses trans ior-
danem possessionem absq; leuitis - qui
nichil terre accepere inter fratres suos:
sed in eis tantummodo locis filij ioseph
in duas diuisi tribus manasse r ephra-
im. Nec acceperũt leuite aliam in terra
parte nisi urbes ad habitandũ-et sub-
urbana earũ ad alendas animalia et pecu-
ra sua. Sicut preceperat dñs moysi-ita
fecerunt filij israel et diuiserũt terram.
Accessit itaq; filij iuda ad iosue in fima quita.
galgala: et caleb filius iephone cenezeus. Nosti quid locutus
sit dñs ad moysen hominẽ dei de me
et te in cadesbarne. Quadraginta an-
norum eram quãdo misit me moyses
famulus dei de cadesbarne ut explo-
rarẽ terrã: nuntiauiq; ei q; michi ve-
rum videbatur. Fratres aũt mei qui
ascenderãt mecũ dissoluerãt cor pop-
li: r michi dominus ego secutus sum dñm
deum meum. Iurauitq; moyses in
die illo dicens. Terra quã calcauit pe
tuus erit possessio tua et filioꝝ tuorũ
in eternũ: quia secutus es dñm deum meum.
Concessit ergo dñs vitam michi sicut
pollicitus est usq; in presentem diẽ. Qua-
draginta et quinq; anni sunt ex quo
locutus ẽ dñs verbum istud ad moy-
sen-quando ambulabat israhel per so-
litudinẽ. Hodie octogintaquinq; an-
norũ sum sic valens ut eo tempore
quãdo ad explorandũ missus sum. Tunc
in me robur fortitudo usq; hodie per-
seuerat: tam ad bellandũ q; ad gradi-
endum. Da ergo michi montem istum
quẽ pollicitus ẽ dominus et quoq; au-
dierit ẽ quia anachim sint et urbes ma-
gne atq; munite: si forte sit dominus

Francis Bacon
Empiricism

Rene Descartes
Rationalism

Empiricism

- Knowledge is derived from experience/experimentation
- Experimental science is the paradigm of knowlegde
- Experimental science can not produce certainty

Rationalism

- Knowledge is derived from reason and logic
- Mathematics is the paradigm of knowledge
- Genuine knowledge is certain because it is rational

Empiricism

Francis Bacon (1561-1626)

Baconian Method

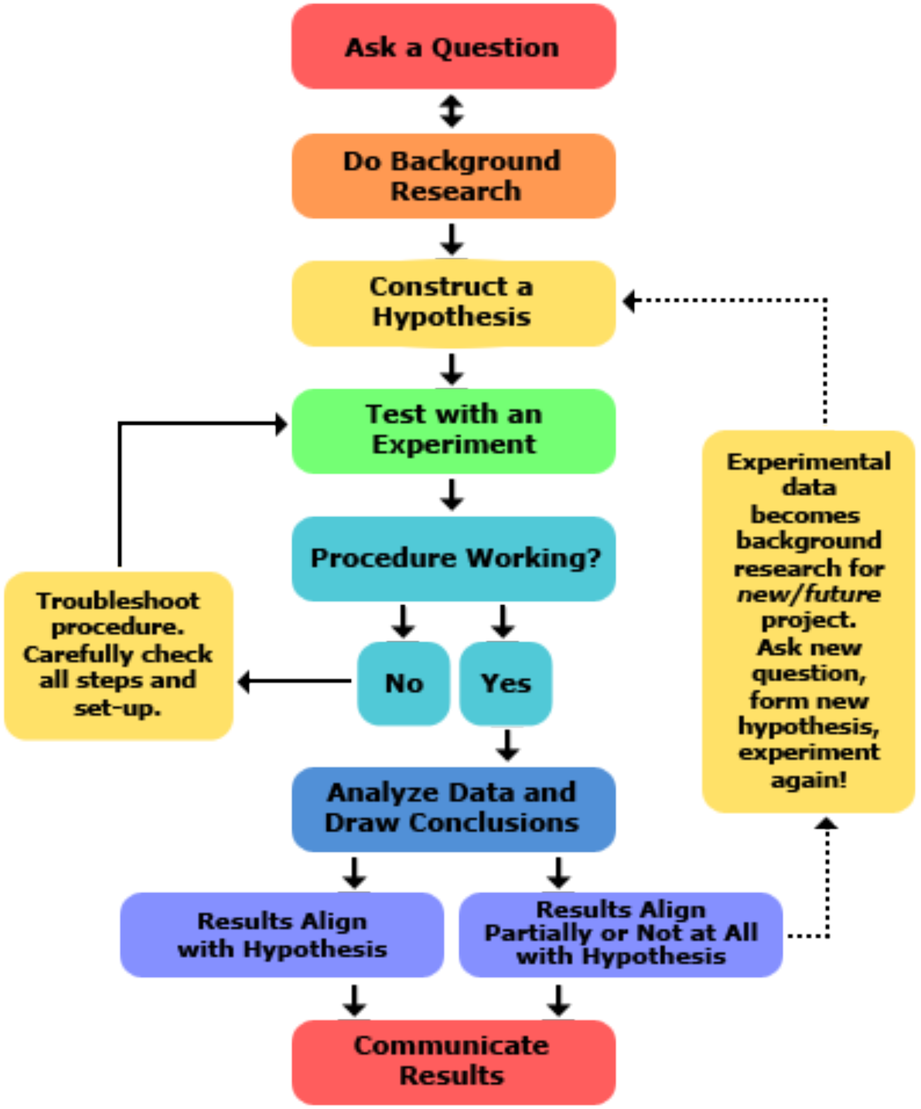
Novum Organum (New Method) - 1620

?

**“For while men believe their reason governs words,
in fact, words turn back and reflect their power upon the understanding,
and so render philosophy and science sophistical and inactive.”**

Francis Bacon

Scientific Method

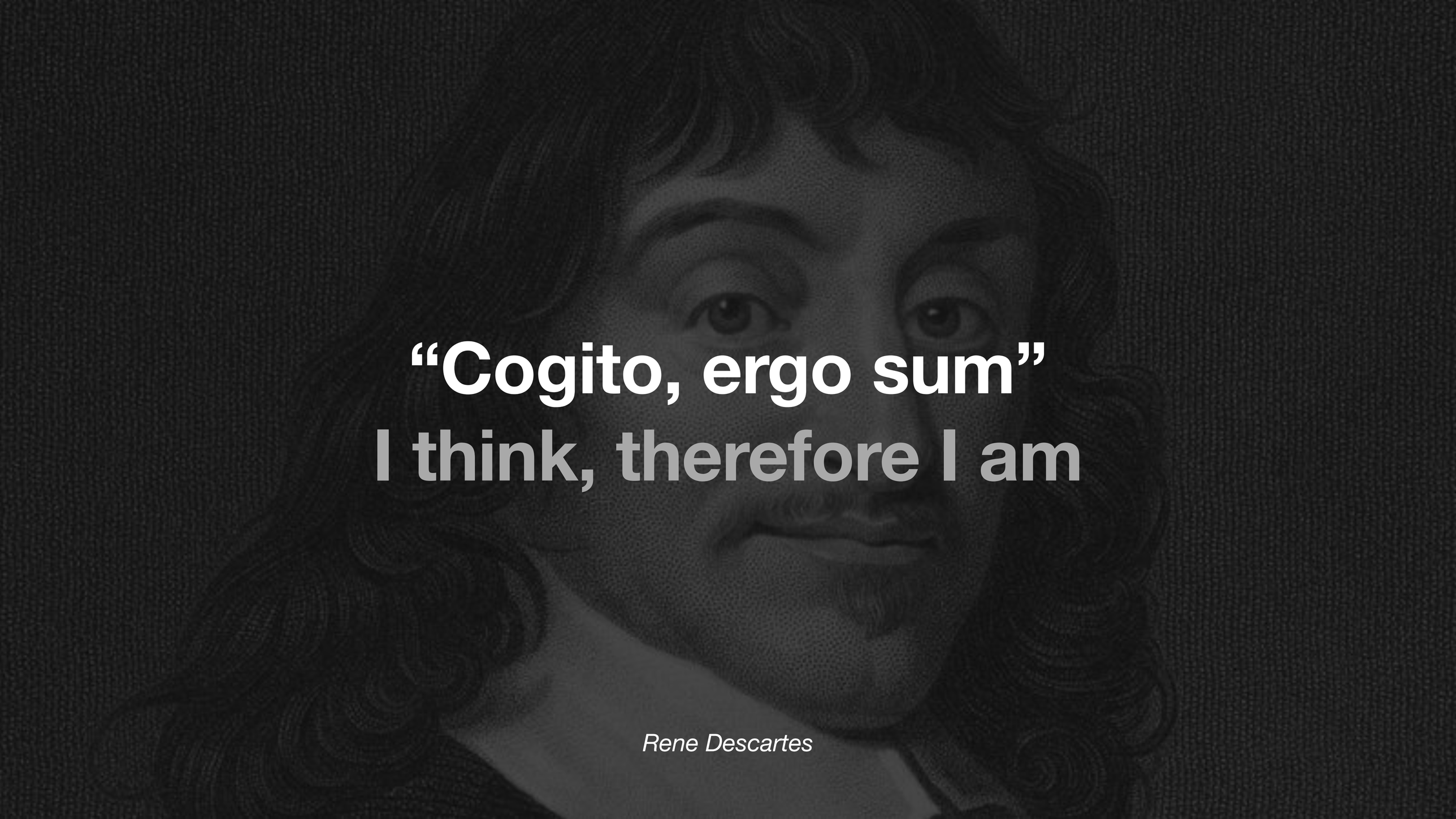

Ask a Question
Do Background Research
Construct a Hypothesis
Test with an Experiment
Procedure Working?
No
Yes
Troubleshoot procedure. Carefully check all steps and set-up.
Analyze Data and Draw Conclusions
Results Align with Hypothesis
Results Align Partially or Not at All with Hypothesis
Communicate Results
Experimental data becomes background research for *new/future* project. Ask new question, form new hypothesis, experiment again!

Rationalism

Rene Descartes (1696-1650)

Rene Descartes

Rene Descartesian coordinates


“Cogito, ergo sum”
I think, therefore I am
Rene Descartes

$$\frac{}{a+2bx\sqrt{a+bx}} = y. \qquad \frac{}{\sqrt{a+bx}} = x.$$

$$\frac{bx\sqrt{ac+dzz+cbxx}}{a+bx\sqrt{a+bx}} = y. \quad \sqrt{c+dzz} = v. \qquad \frac{c}{\sqrt{a+bxx}} = x.$$

$$\frac{-b\sqrt{acxx+dzzxx+cbx}}{ax^2+2bx\sqrt{axx+bx}} = y. \quad \sqrt{c+dzz} = v. \qquad \frac{cx}{\sqrt{axx+bx}} = z.$$

$$\frac{-b\sqrt{acxx+dzzxx+cb}}{ax^3+bx\sqrt{axx+b}} = y. \quad \sqrt{c+dzz} = v. \qquad \frac{cx}{\sqrt{axx+b}} = z.$$

$$\frac{4m^4ddxx+4maabcdx+bbcd}{2aaxx+2bx\sqrt{4a+ddxx+4aabdd}x} = y. \quad \sqrt{cc+ddzz} = v. \quad \frac{cb}{2ad\sqrt{aax^2+bx}} =$$

$$\frac{4+ddx^4+4aabcdxx+bbcd}{2x^3+bx\sqrt{2ad\sqrt{aax^4}+bxx}} = y. \quad \sqrt{cc+ddzz} = v. \quad \frac{cb}{2adx\sqrt{a^2x^2+b}} =$$

$$\frac{4a^4cd-4aabcdx-bbcdxx}{aax+2bxx\sqrt{2ad\sqrt{aa+bx}}} = y. \quad \sqrt{cc+ddzz} = v. \quad \frac{cbx}{2ad\sqrt{aa+bx}} = z$$

$$\frac{+a^4cdx^2+4aabcdx^4-bbcdx^6}{a+bx\sqrt{2ad\sqrt{aa+bxx}}} = y. \quad \sqrt{cc+ddzz} = v. \quad \frac{cbxx}{2ad\sqrt{aa+bxx}} =$$

In General.

$$\frac{ax^m+mbx^n\sqrt{cax^m+cbx^n+dcc}}{x^{m+1}+2bx^{n+1}\sqrt{ax^m+bx^n}} = y. \quad \sqrt{c+dzz} = v. \quad \frac{\varepsilon}{\sqrt{ax^m+bx^n}} = z.$$

$$\frac{max^{m-1}+mnbx^{n-1}\sqrt{cax^m+cbx^n+dcc}}{2aax^{2m}+4abx^{m+n}+2bbx^{2n}} = y. \quad \sqrt{c+dzz} = v. \quad \frac{\varepsilon}{\sqrt{ax^m+bx^n}} =$$

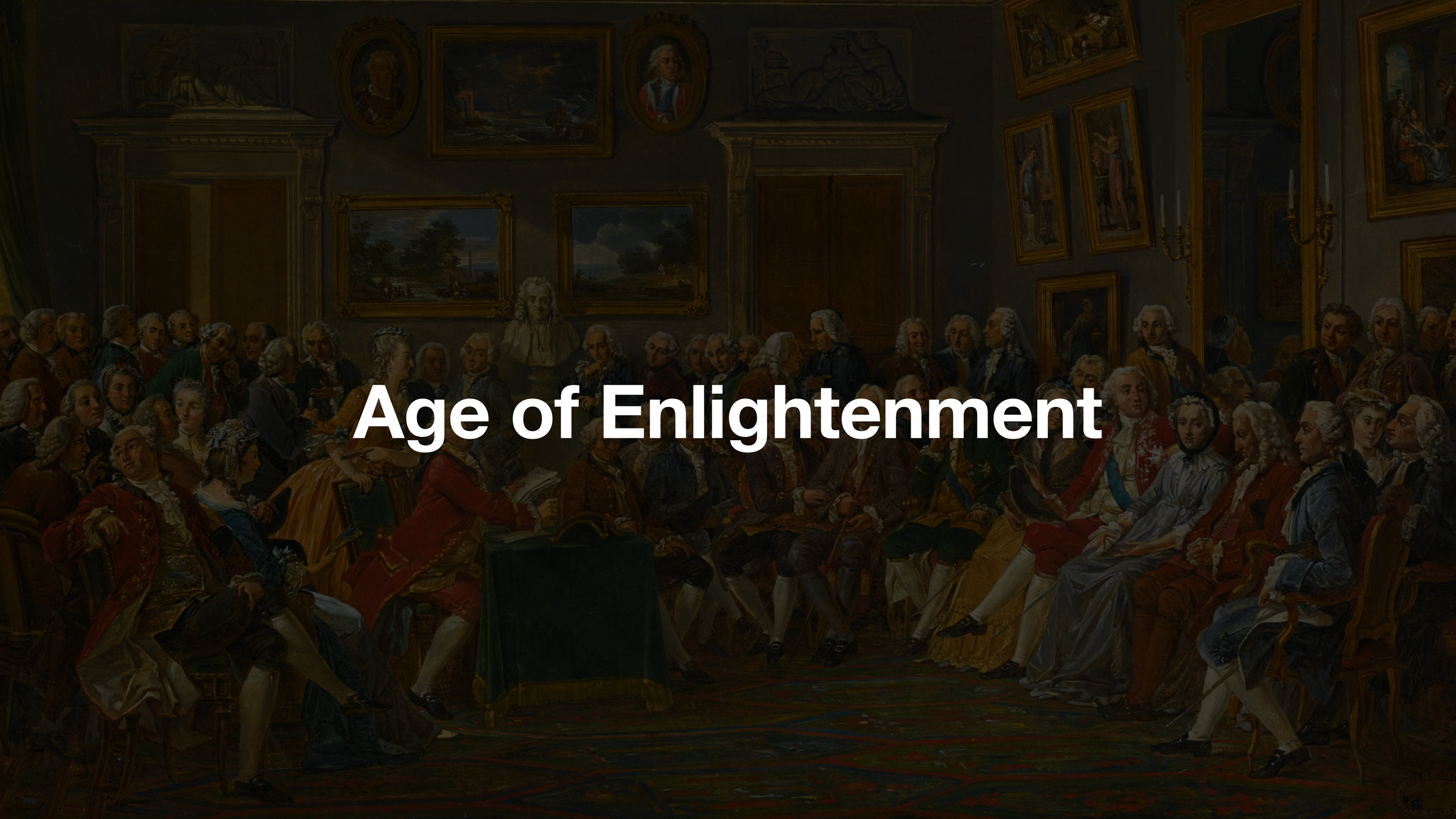
$$\frac{ccb3xx}{a+2abxx+bbx^4} = y. \quad \sqrt{cc-\frac{acc}{\varepsilon\varepsilon}zz} = v. \quad \frac{\varepsilon}{\sqrt{a+bbxx}} = z.$$

In General

$$\frac{b3cc\,x^{\frac{3n-2}{2}}}{aa+4abx^n+2bbx^{2n}} = y. \quad \sqrt{cc-\frac{acc}{\varepsilon\varepsilon}zz} = v. \quad \frac{\varepsilon}{\sqrt{a+bbx^n}} = z.$$

Institutionalization

NULLIUS
IN
VERBA



Age of Enlightenment