Galileo Galilei

Born Pisa 1564

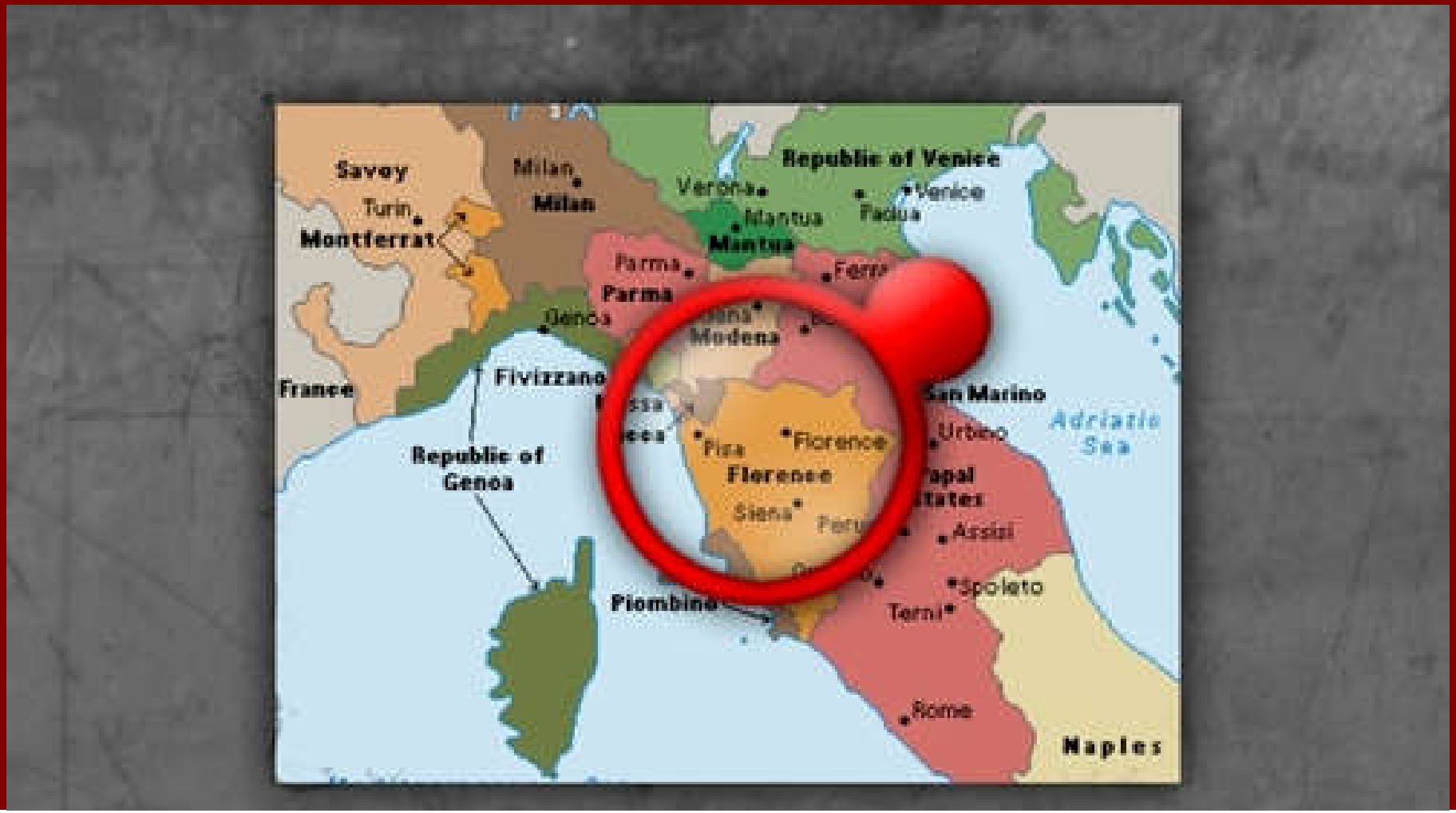
Died Florence 1642

ASSA Symposium

Durban

August 2008

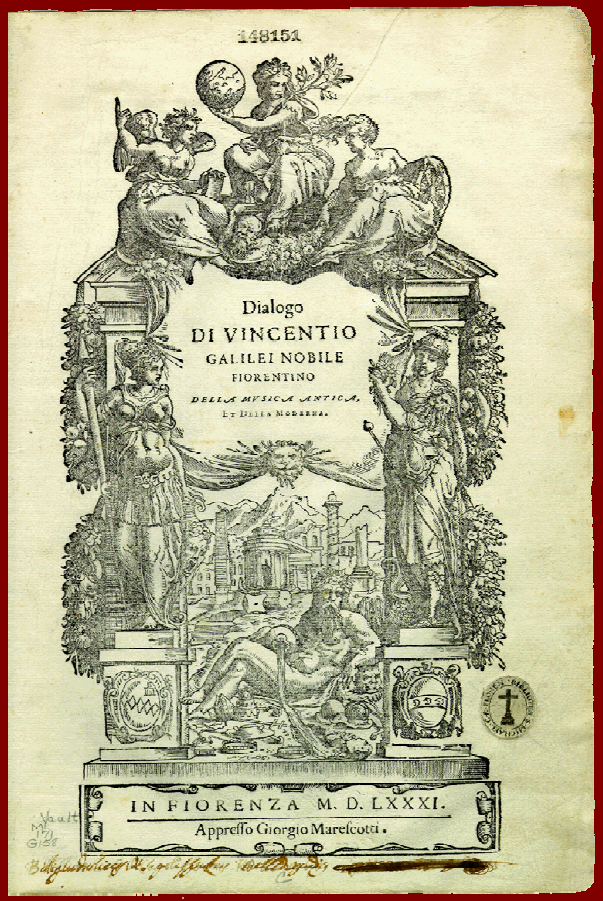
Grand Duchy of Tuscany
(Under domination of the Papal States)

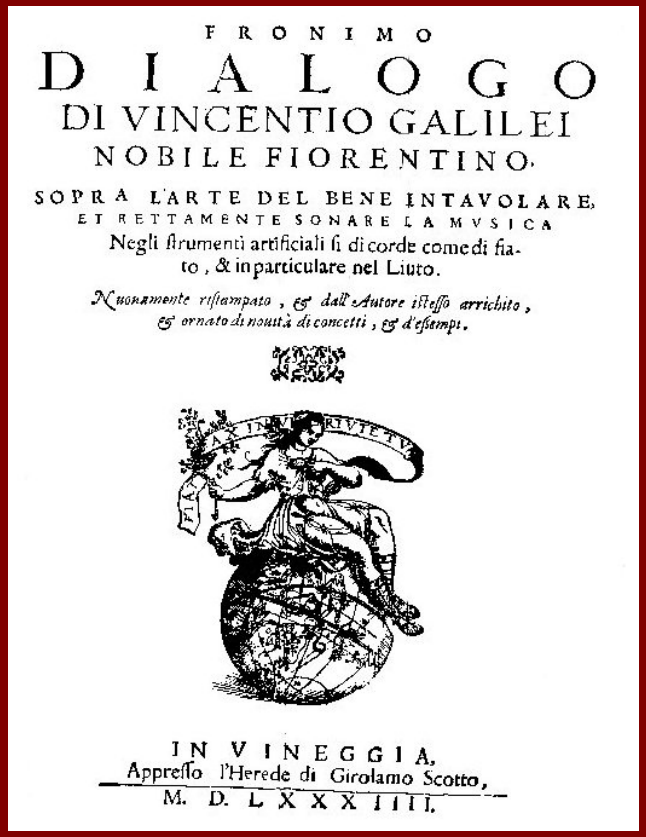


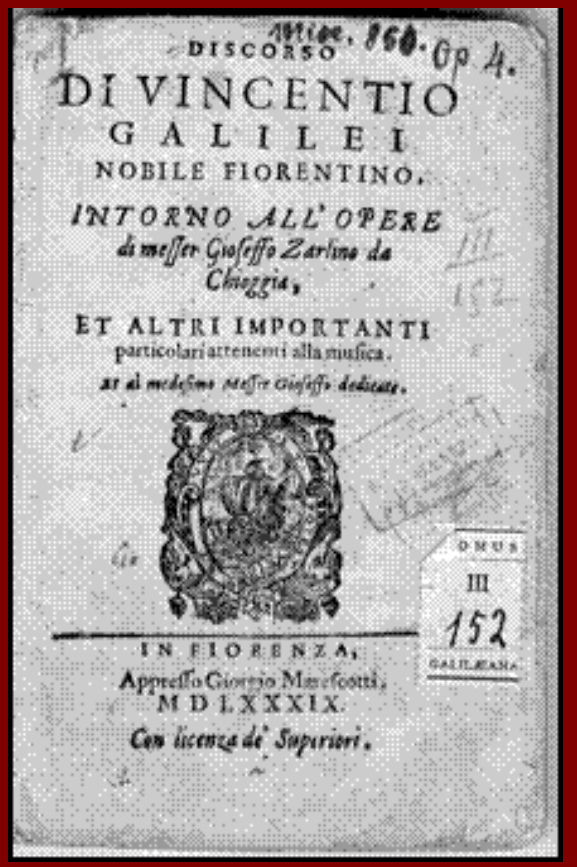
Birthplace of Galileo - Pisa

Vincenzio Galilei – Galileo's father

Experimenter and musical theorist







Vincenzio Galilei - Ricercare

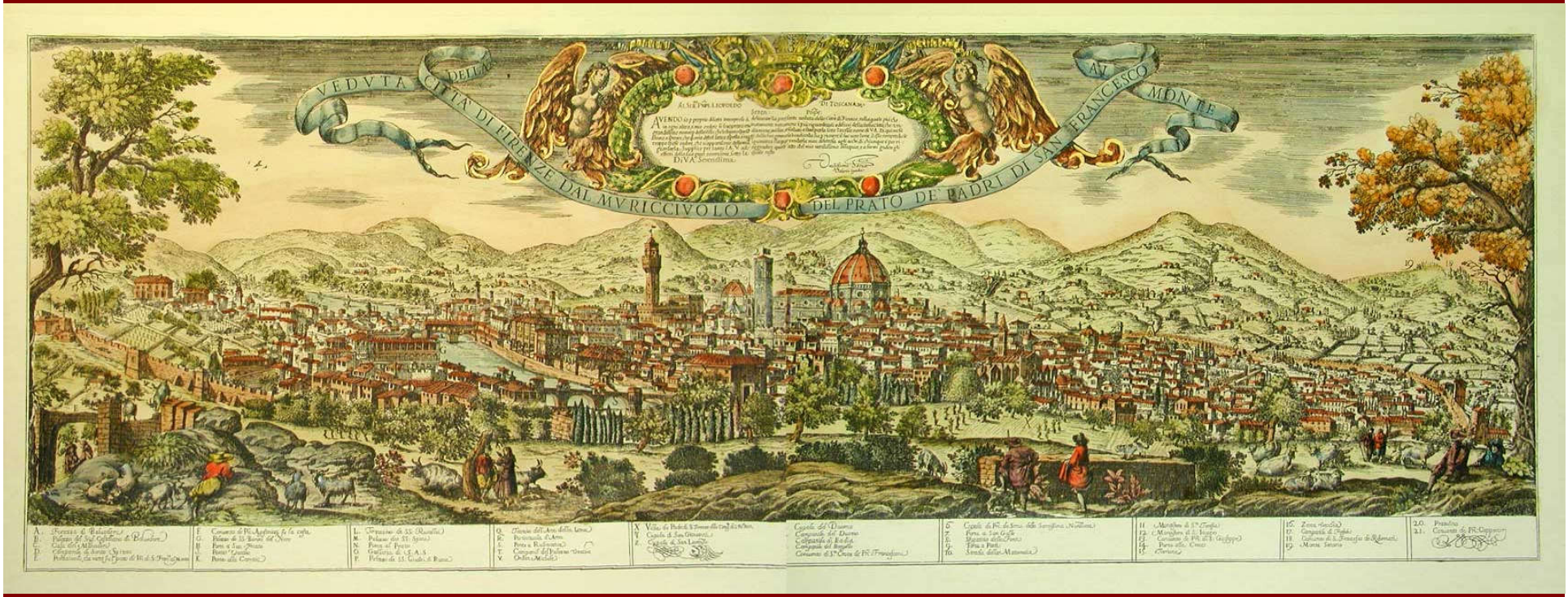
Education

- **Camaldolese (Benedictine) monastery of Vallombrosa**
- **Private teachers**
- **University of Pisa – medicine and Aristotelian philosophy**

Galileo's life - Timeline

- 1564 birth in Pisa (Grand Duchy of Tuscany)
- 1581 studies medicine
- 1585 studies geometry - teacher in Florence
- 1587 visits Rome
- 1589-1592 Prof at Pisa
- 1592-1610 Prof at Padua (Rep. of Venice)
- 1597 Convinced of Copernicanism
- 1603 acceleration of falling bodies
- 1604 Kepler's supernova
- 1609 first telescope
- 1610 publishes Sidereus Nuncius
- 1610 Prof in Pisa; Philosopher to Grand Duke of Tuscany
- 1613 publishes book on sunspots
- 1615 publishes views on the Bible
- 1615 first problems with church
- 1618 comets
- 1623 publishes *The Assayer*
- 1632 publishes *Dialogue* favouring Copernicanism
- 1633 Trial by Inquisition; house arrest
- 1638 Publishes *Discourse on Two New Sciences*
- 1637 libration of the Moon
- 1637 blindness
- 1642 death in Arcetri near Florence

Florence – Renaissance City



Visit to Rome (1587)

Collegio Romano, intellectual HQ of the Jesuit Order

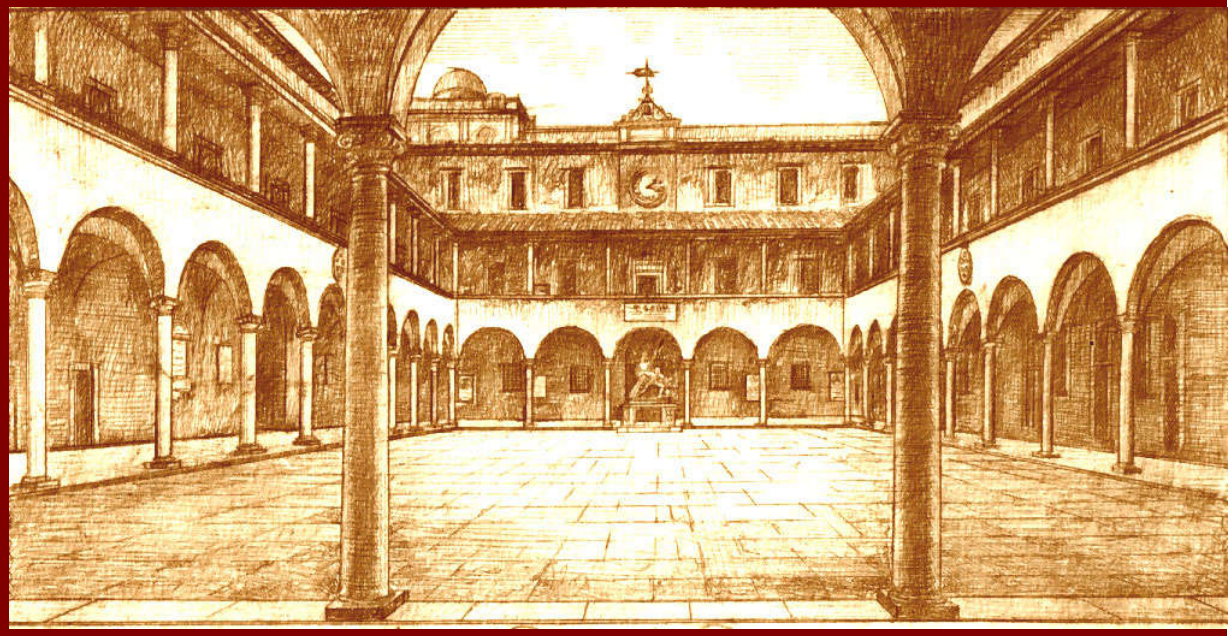
Clavius (Christopher Clau SJ)

- Mathematician behind the Gregorian calendar promulgated by Pope Gregory XIII in 1582.
- Impressed with Galileo's work on centres of gravity.

Another picture!

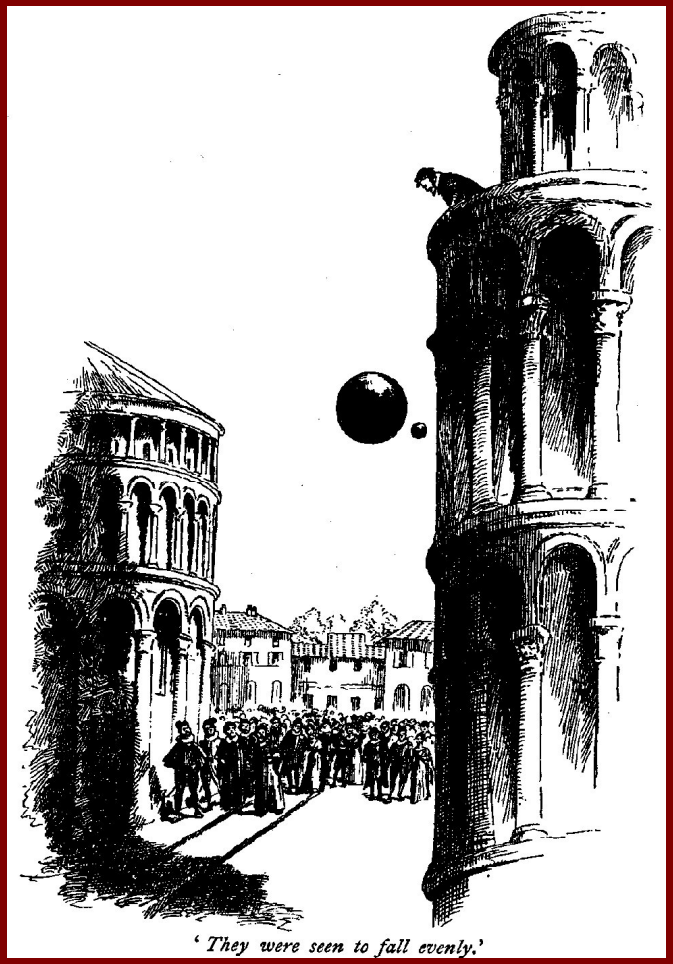
Pisan Professorship 1589-1592

- Beginnings of experimental work; inclined planes etc.
- Beginnings of concept of inertia
- Anti-establishment, especially Aristotelians
- Poem: “Against wearing gowns”



University of Pisa

Pisan legends!



'They were seen to fall evenly.'

Aristotelian science

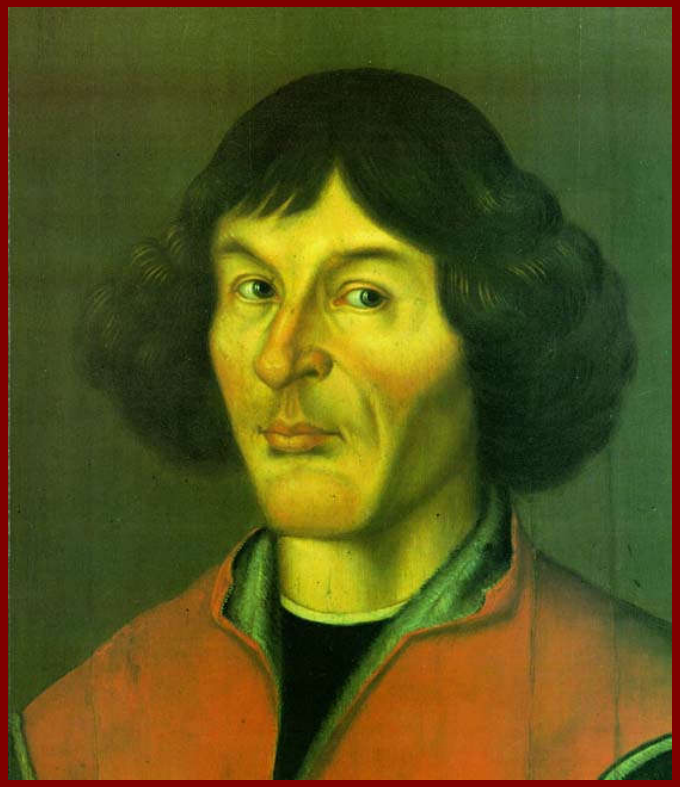
The bane of the late Middle Ages – supported vociferously by the academic world and many theologians

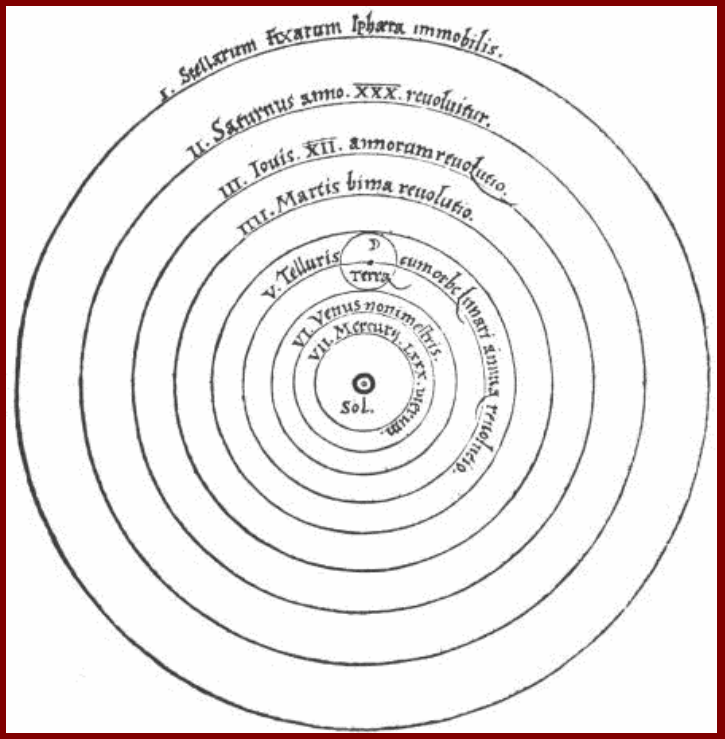
- The earth is the centre of the universe; the sun and other bodies revolve around it.
- Terrestial substances are composed of earth, air, fire and water but the heavens are made of of a “perfect” material
- No changes occur in the heavens
- Heavenly bodies move only in perfect circles or combinations thereof
- Ptolemaic theory: invisible spheres support and drive the planets, whose motions can be described by epicycles
- Observation unimportant compared to logic

Padua 1592-1610

Venetian Republic – intellectually free

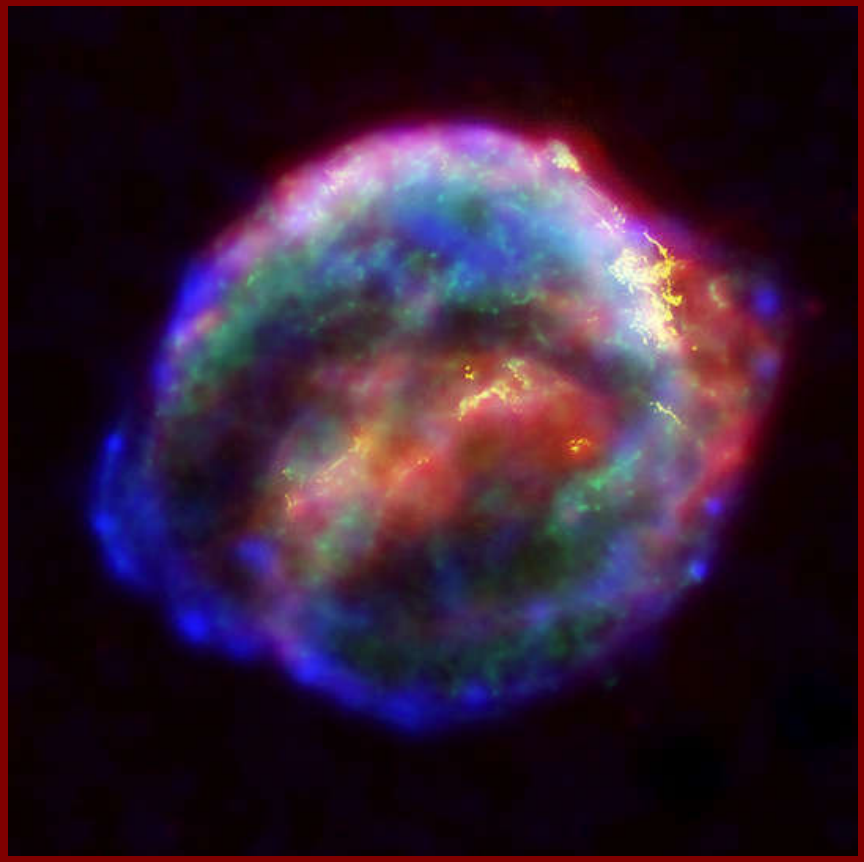
Paduan professorship 1592-1610





Copernicus published his *De Revolutionibus* … in 1543.
Not accepted until Kepler and Galileo's times

Johannes Kepler's supernova of 1604



First portrait of Galileo?

- 19th century engraving of a supposedly lost 1603-1604 portrait.
- Can it be genuine?
- ----------
- Marina Gamba
- 3 children
- ----------
- Best science
- Many private pupils

Invention of the telescope

- October 2, 1608: Hans Lippershey of Middelburgh, Netherlands, a spectacle maker, applied for a patent on a telescope.

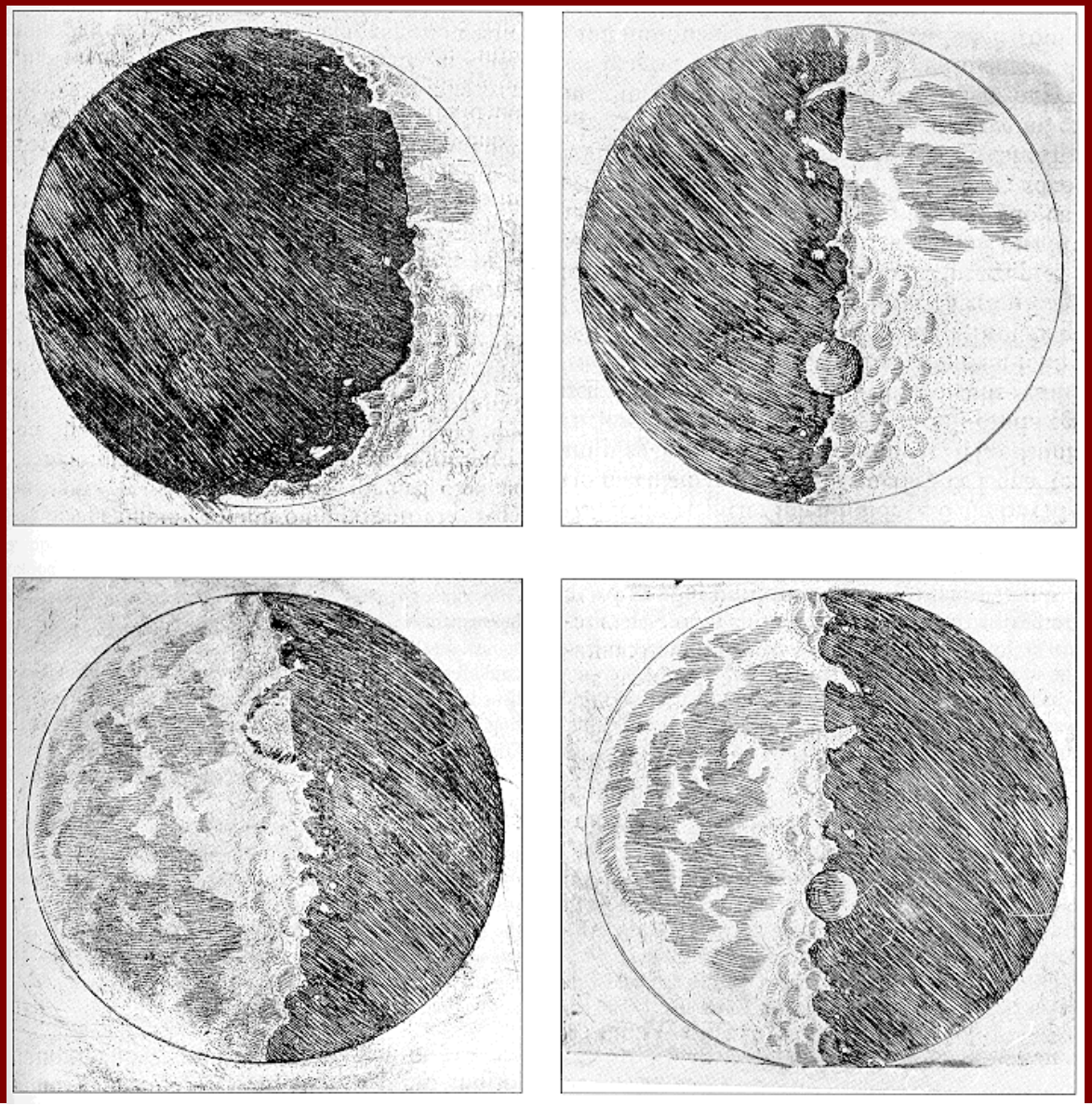
- There were other claimants and Lippershey's application was denied.

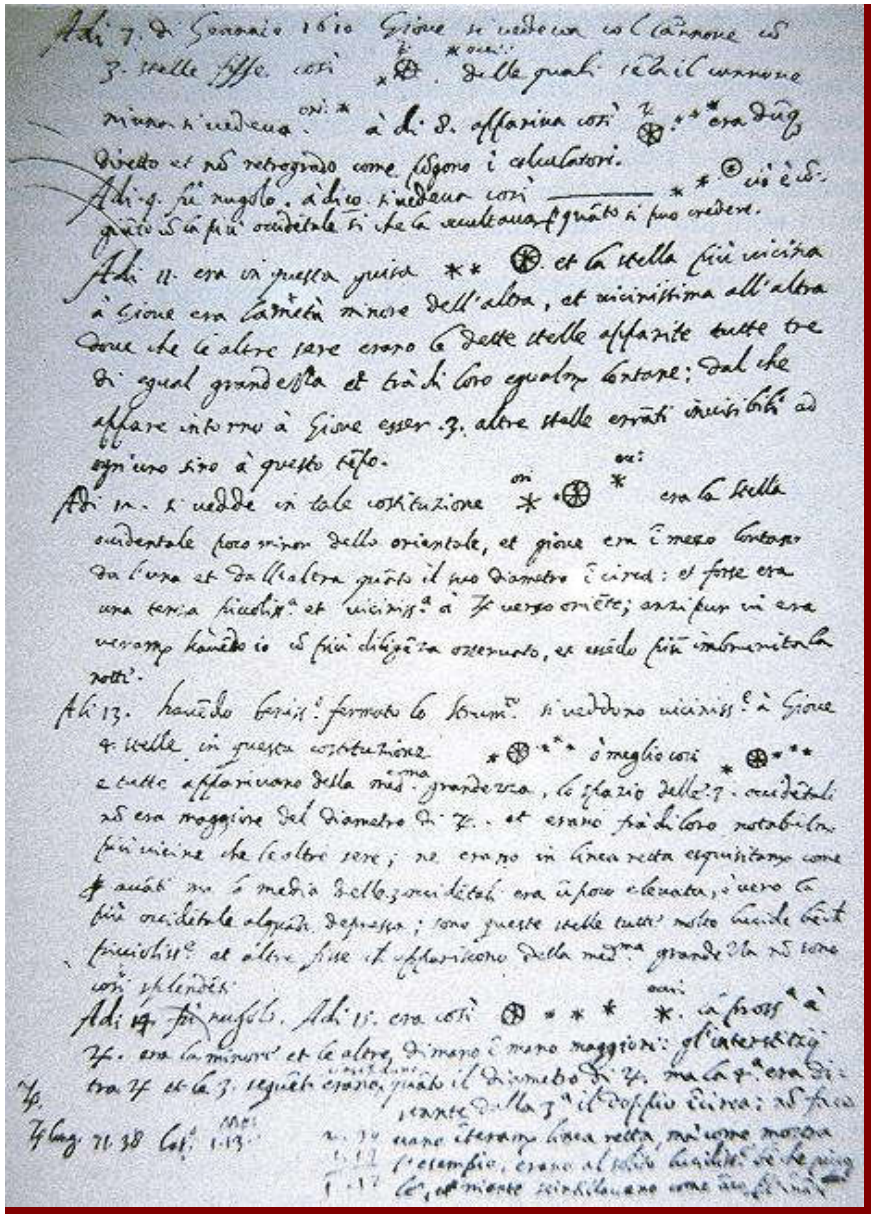
Advent of the telescope

- Galileo heard of telescope in July 1609 and guessed how it is made. Grinds own lenses.
- Sold an 8-power model as a military instrument to the Venetian government, receiving tenure and a huge increase in salary.
- By November 1609 had a 20-power instrument.

Wooing the Venetian government

Astronomical discoveries – lunar mountains

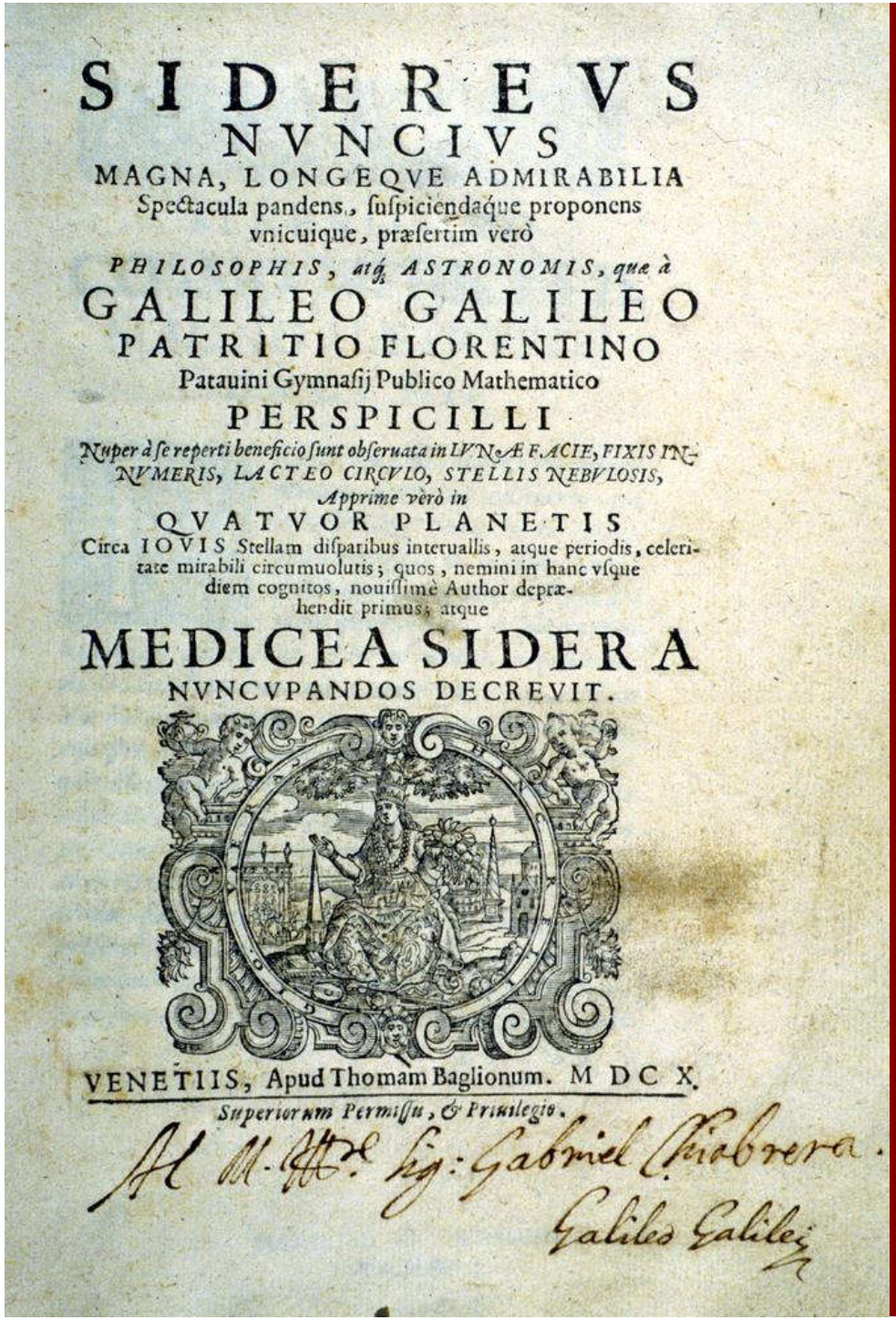




Observations of the four Inner moons of Jupiter. (January 1610)

Galileo’s observations of the Pleiades (“Seven Sisters”)

Galileo's observations on the Pleiades



SIDEREVS
NVNCIVS
MAGNA, LONGEQVE ADMIRABILIA
Spectacula pandens, ſuſpiciendaque proponens
vnicuique, præſertim verò
PHILOSOPHIS, atq; ASTRONOMIS, quæ à
GALILEO GALILEO
PATRITIO FLORENTINO
Patauini Gymnaſij Publico Mathematico
PERSPICILLI
Nuper à ſe reperti beneficio ſunt obſeruata in LVNÆ FACIE, FIXIS IN-
NVMERIS, LACTEO CIRCVLO, STELLIS NEBVLOSIS,
Apprime verò in
QVATVOR PLANETIS
Circa IOVIS Stellam diſparibus interuallis, atque periodis, celeri-
tate mirabili circumuolutis; quos, nemini in hanc vſque
diem cognitos, nouiſſimè Author depræ-
hendit primus; atque
MEDICEA SIDERA
NVNCVPANDOS DECREVIT.

VENETIIS, Apud Thomam Baglionum. M DC X.
Superiorum Permiſſu, & Priuilegio.

Ad M. Ill.re Sig.r Gabriel Chiabrera.
Galileo Galilei

SIDEREAL MESSENGER

GREAT AND WONDERFUL

Sights displayed for all to see but

especially for

PHILOSOPHERS and ASTRONOMERS by

GALILEO GALILEI

PATRICIAN OF FLORENCE

Public Mathematician of the University of Padua

By means of a

PERSPICILLUM

Newly devised by him, there are observed the surface of the moon, innumerable fixed stars, the Milky Way and nebulous stars, but especially

FOUR PLANETS

flying around Jupiter at unequal distances and periods

Which, never seen before, have recently been seen for the first time by the author and named by him as

MEDICEAN STARS

-

Venice, at Thomas Baglionum, 1610

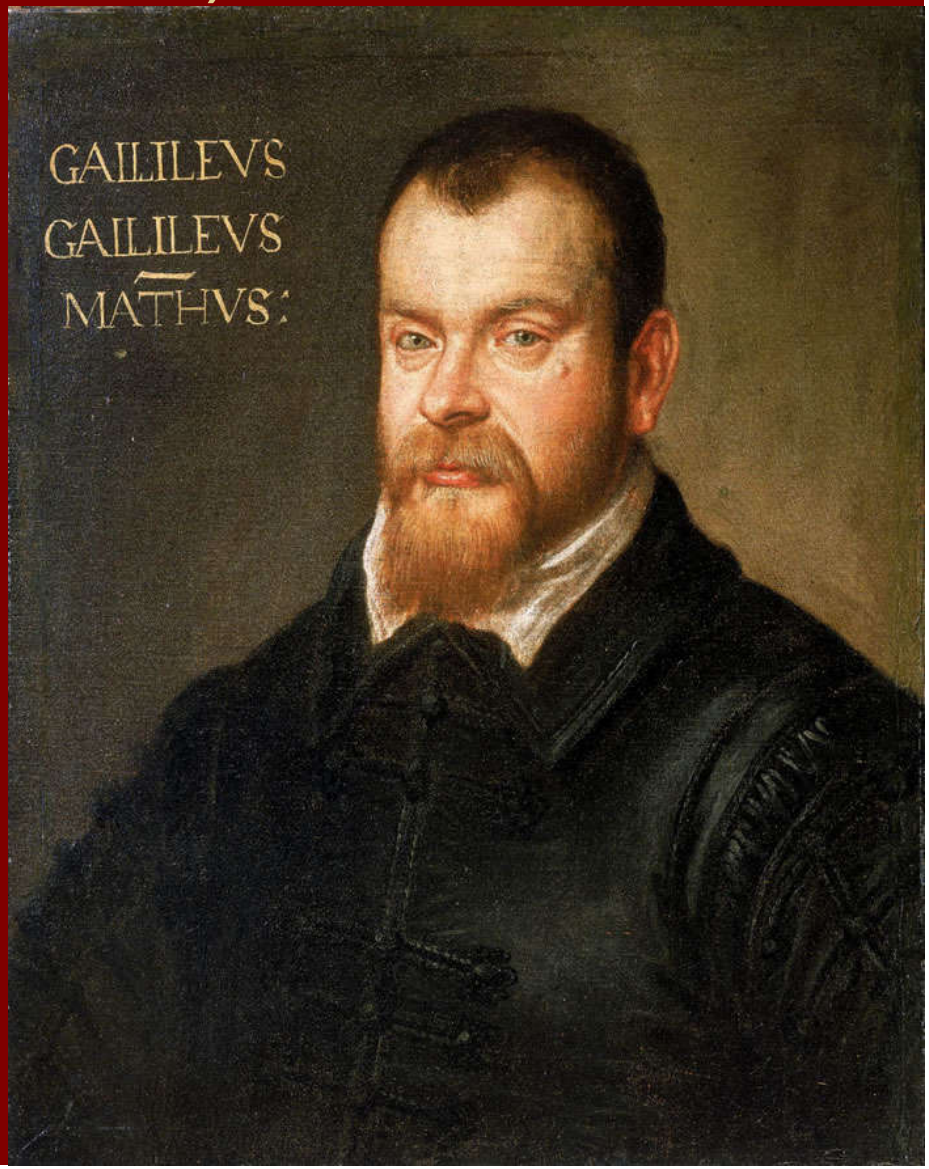
With permission and privilege

Return to Medici court in Florence 1610

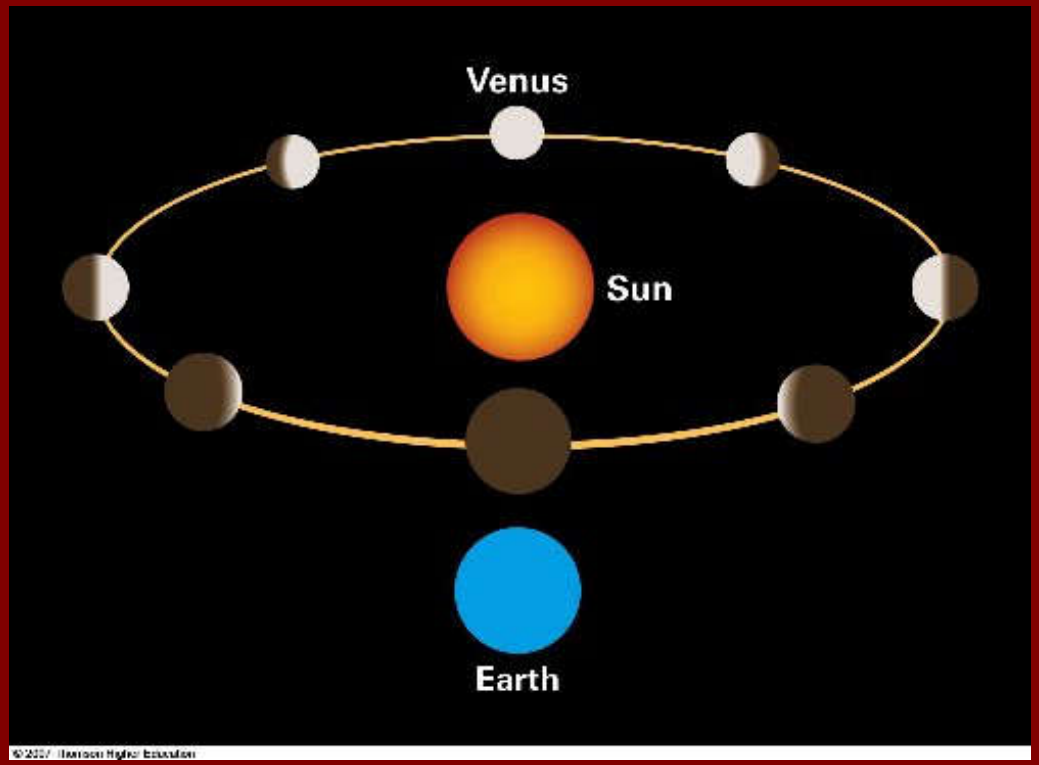
- Cosimo II de Medici with wife and son Ferdinando II

Portrait of Galileo 1610 - 1615 (aged 46 - 51)

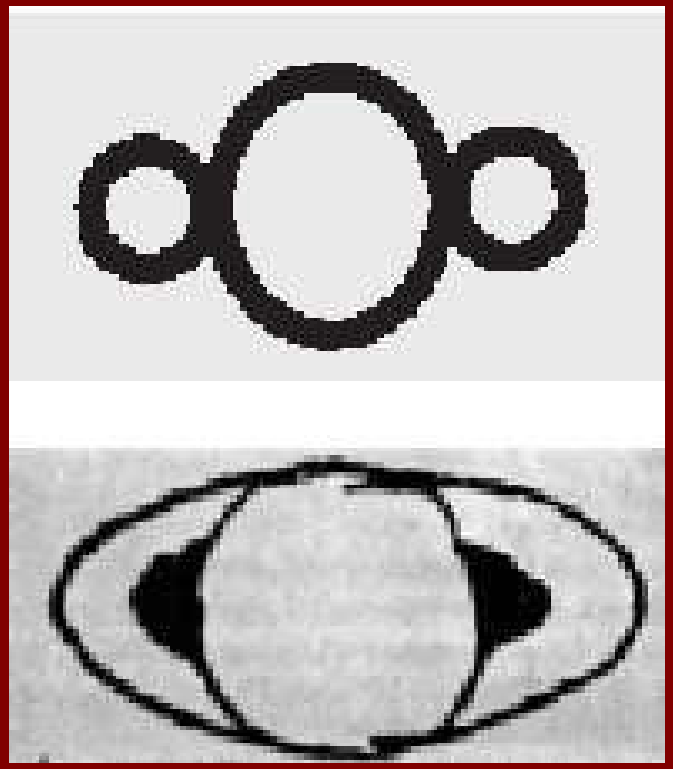
- Considered to be by the Venetian painter Domenico Robusti, son of “Tintoretto”.



Phases of Venus – end of 1610 (strong proof of Copernican viewpoint)



Saturn and its rings



1610

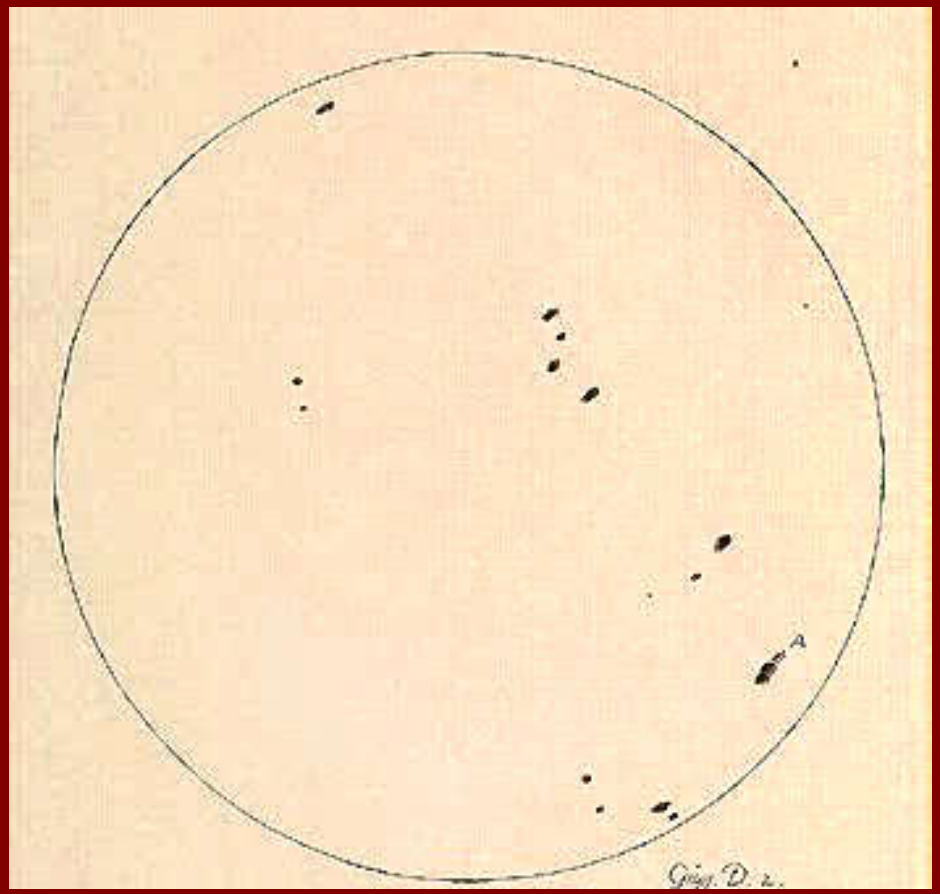
1616

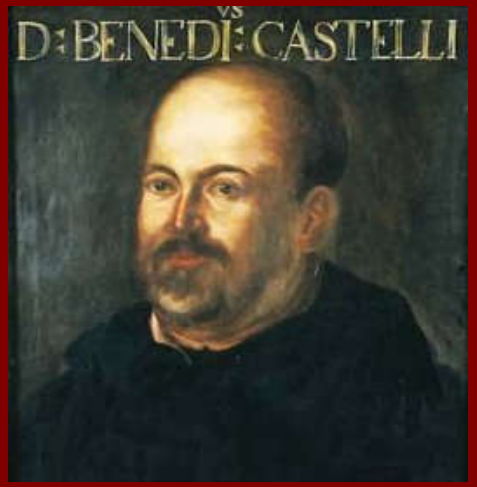
- Galileo's telescope did not have enough resolution to see the rings properly.
- In 1612 they had disappeared (now known they were edge-on)

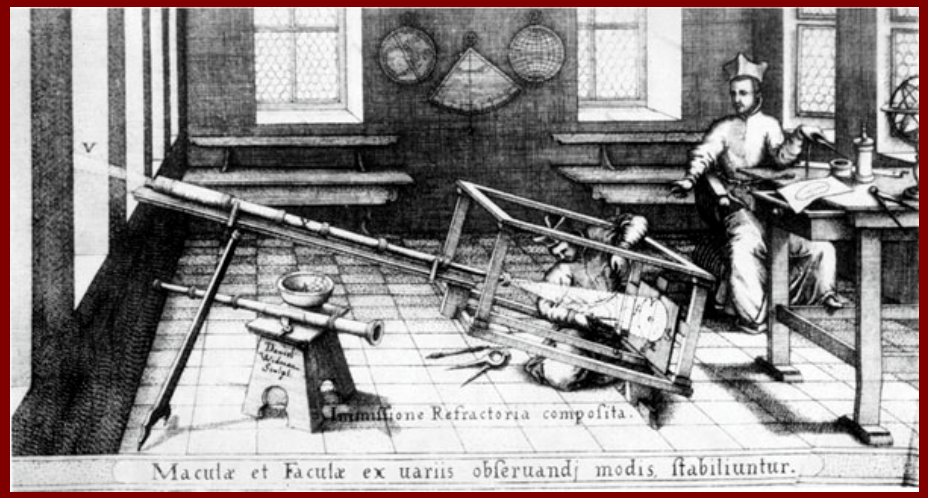
Sunspot drawings 2 June - 8 July 1613

Projection telescope invented by Galileo's pupil Benedetto Castelli;

Also used by his rival sunspot observer Christopher Scheiner SJ







Beginnings of trouble with the Church

- In December 1613, Grand Duchess Christina, at a dinner party, questioned Galileo's pupil Castelli about Galileo's orthodoxy.
- Attacked from the pulpit in Florence in 1614 by Tomaso Caccini, a Dominican priest.
- Galileo was Reported to Cardinal Bellarmine of the Holy Office (Inquisition). He was a known anti-Copernican
- Galileo wrote a "letter" to the Grand Duchess defending his views.

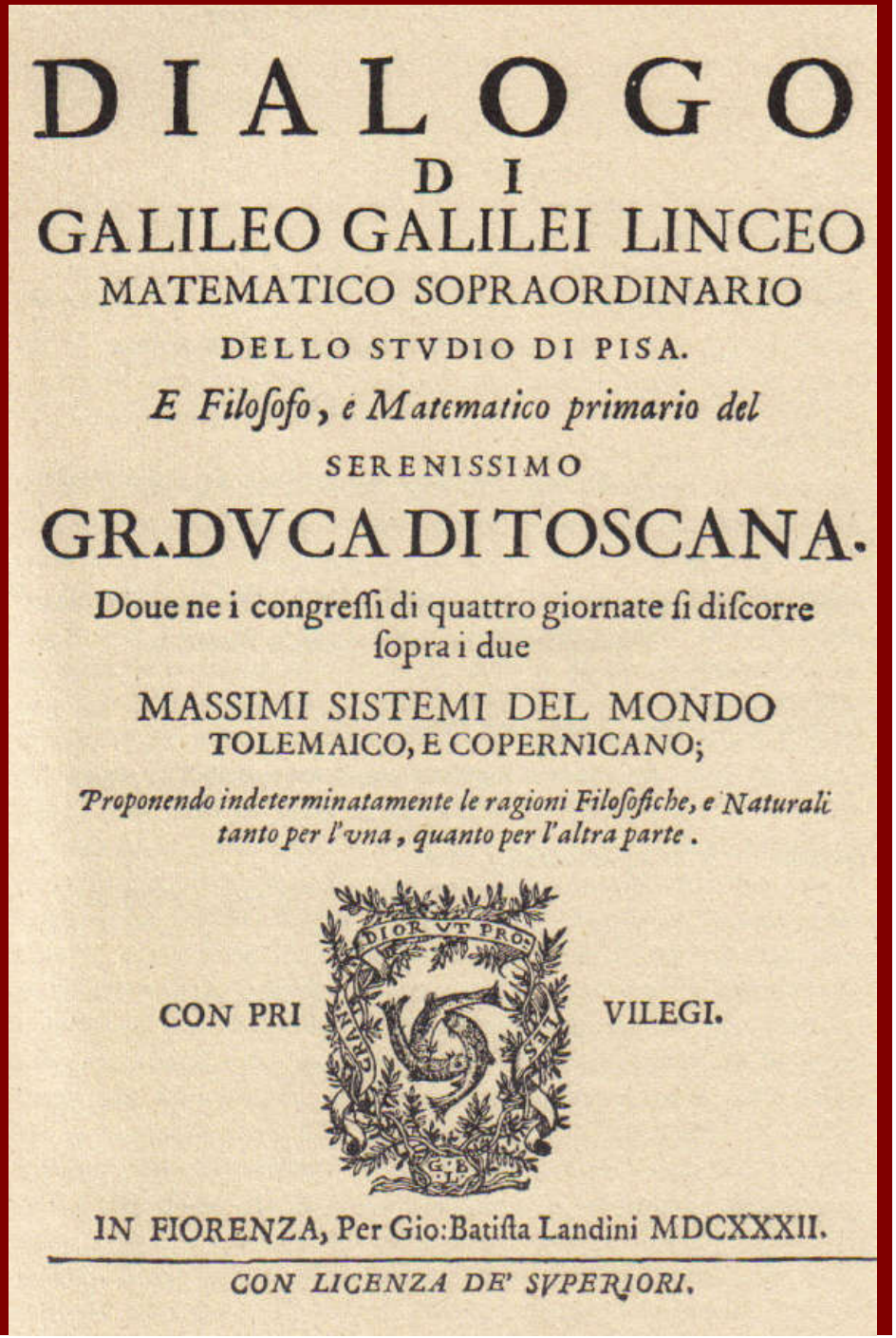
Cardinal Bellarmine and the Inquisition

- The Inquisition was asked by Pope Paul V to check up on whether the motion of the earth was in accord with biblical teaching – report was negative.
- Bellarmine, its leading theologian, warned Galileo that Copernican views were contrary to scripture and could not be defended or held.
- However, they could be referred to as a model useful in making calculations.

Il Saggiatore (the Assayer), written in 1623

- “Philosophy is written in the greatest book, one that stands open before our eyes (I speak of the universe). But it cannot be comprehended without first understanding its language and knowing the characters in which it is written. That language is mathematics, and its characters are triangles, circles and other geometric figures. Without these, it is humanly impossible to understand the words; without these, one wanders vainly about in a dark labyrinth.”

- Galileo's Dialogue concerning the two great world-systems, the Ptolemaic and the Copernican, published in 1632.



DIALOGO
DI
GALILEO GALILEI LINCEO
MATEMATICO SOPRAORDINARIO
DELLO STVDIO DI PISA.
E Filoſofo, e Matematico primario del
SERENISSIMO
GR.DVCA DI TOSCANA.
Doue ne i congreſſi di quattro giornate ſi diſcorre
ſopra i due
MASSIMI SISTEMI DEL MONDO
TOLEMAICO, E COPERNICANO;
Proponendo indeterminatamente le ragioni Filoſofiche, e Naturali tanto per l'vna, quanto per l'altra parte.

CON PRI VILEGI.

IN FIORENZA, Per Gio:Batiſta Landini MDCXXXII.

CON LICENZA DE' SVPERIORI.

Galileo faced the Inquisition in the Convent of Santa Maria Sopra Minerva in Rome

The Trial

M.R. Fleury 1847

Verdict: Convicted of a “vehement suspicion of heresy”.
Forced to abjure.
Sentence: House arrest for life.

Galileo’s house in Arcetri, near Florence

Galileo under house arrest in Arcetri

- as imagined by G.-B. Silvestri in 1833

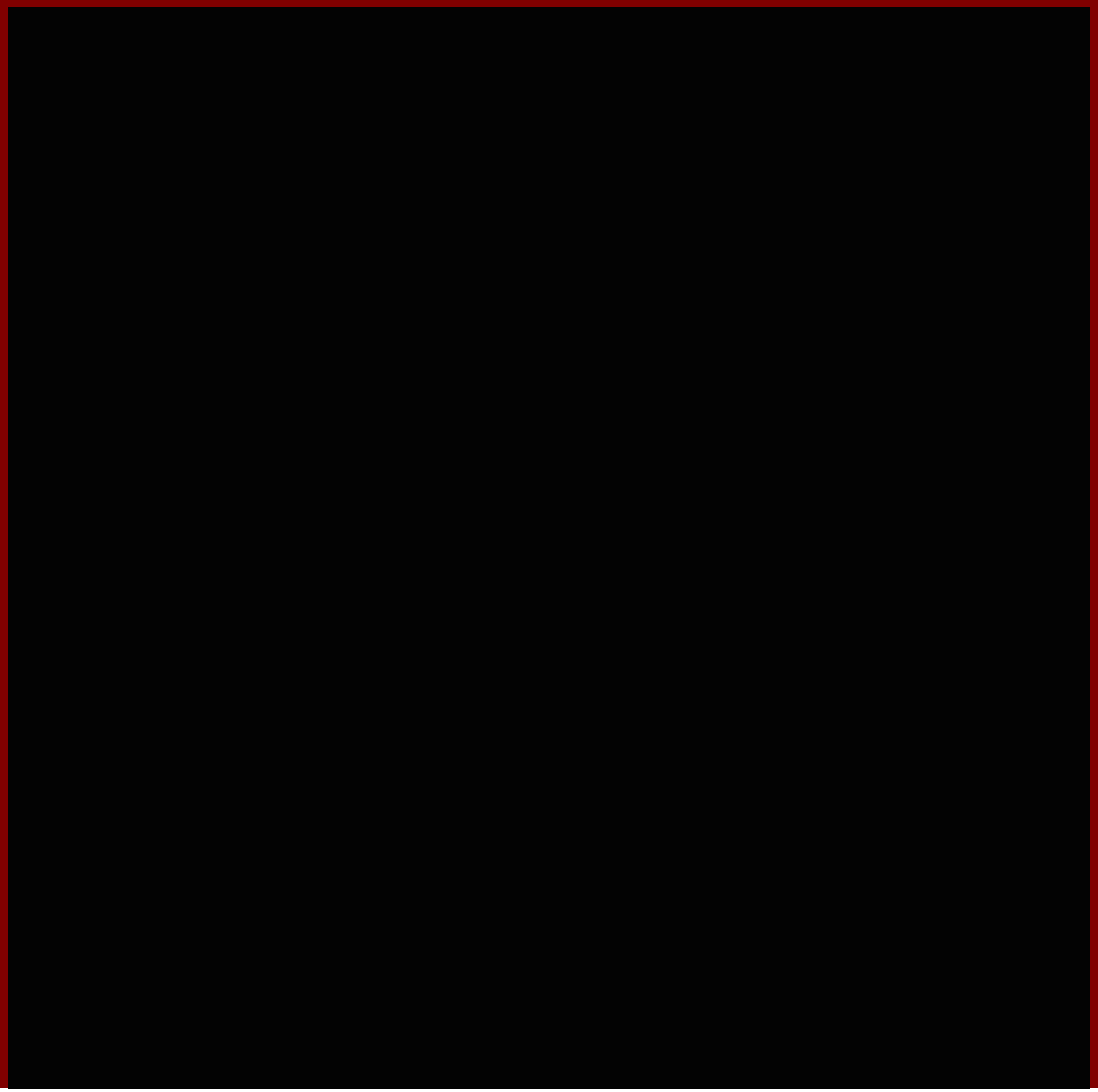
DISCORSI
E
DIMOSTRAZIONI
MATEMATICHE,
intorno à due nuoue ſcienze
Attenenti alla
MECANICA & i MOVIMENTI LOCALI;
del Signor
GALILEO GALILEI LINCEO,
Filoſofo e Matematico primario del Sereniſſimo
Grand Duca di Toſcana.
Con vna Appendice del centro di grauità d'alcuni Solidi.

IN LEIDA,
Appreſſo gli Elſevirii. M. D. C. XXXVIII.

DISCOURSES
AND
MATHEMATICAL
DEMONSTRATIONS
Concerning two new sciences
Relevant to
MECHANICS & LOCAL MOVEMENT
By Signor
GALILEO GALILEI, LINCEAN
Philosopher and first Mathematician to his excellency
The Grand Duke of Tuscany
With an appendix about the centre of gravity of various solids
LEIDEN
Press of the Elsevirs 1638

Portraits from later years. By Gerhard Sustermans

Libration of the Moon (1637)



What Galileo really thought - letter of 1641 to a friend

- The falsity of the Copernican system ought not to be doubted in any way, and most of all not by us Catholics who have the undeniable authority of Holy Scripture, interpreted by the best theologians.

- If the observations and conjectures of Copernicus are insufficient, those of Ptolemy, Aristotle and their followers are in my view even more false.

Final tomb, Santa Croce

- Galileo died in 1642
- He was at first refused burial in Santa Croce because of his “heretical” views.
- Remains placed in this tomb in 1737. The tomb was paid for by his pupil Vincenzio Viviani.

Scientific saint

Relics – finger (left, in IMSS, Florence) and vertebra (right, University of Padua)

Galileo's Legacy

- Scientific method
- Concept of inertia
- Understanding of accelerated movement
- Strength of materials
- Validity of Copernican universe
- Relations between religion and science

The End