ATMOS 2015

Welcome

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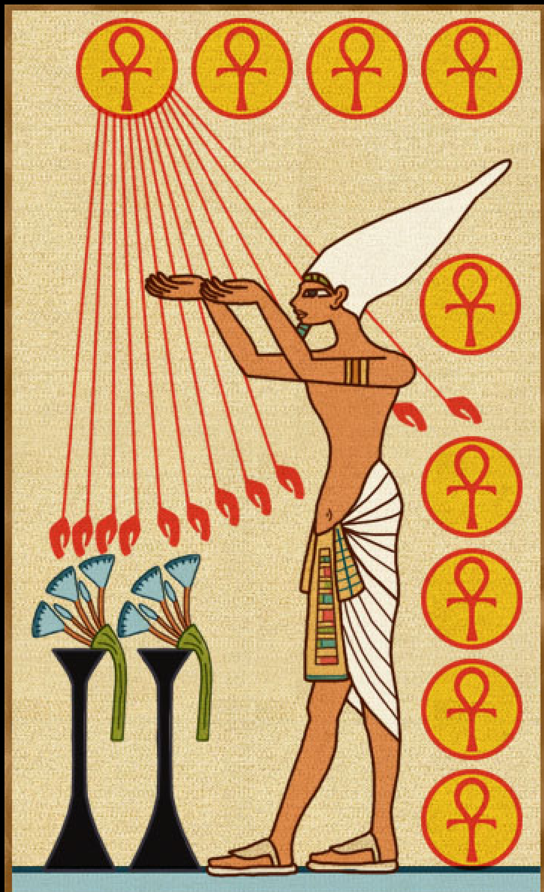
International Ozone Commission

University of Crete, 08-12 June 2015



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CONSTANTINVS
PER CRVCEM
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A S SILVESTRO HIC
BAPTIZATVS
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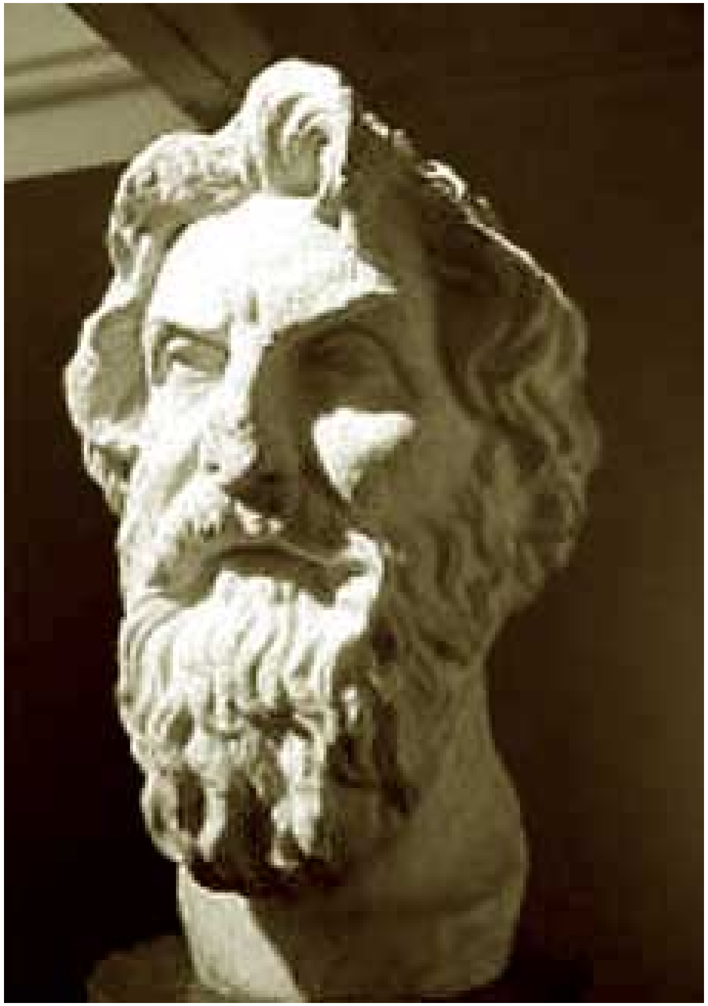
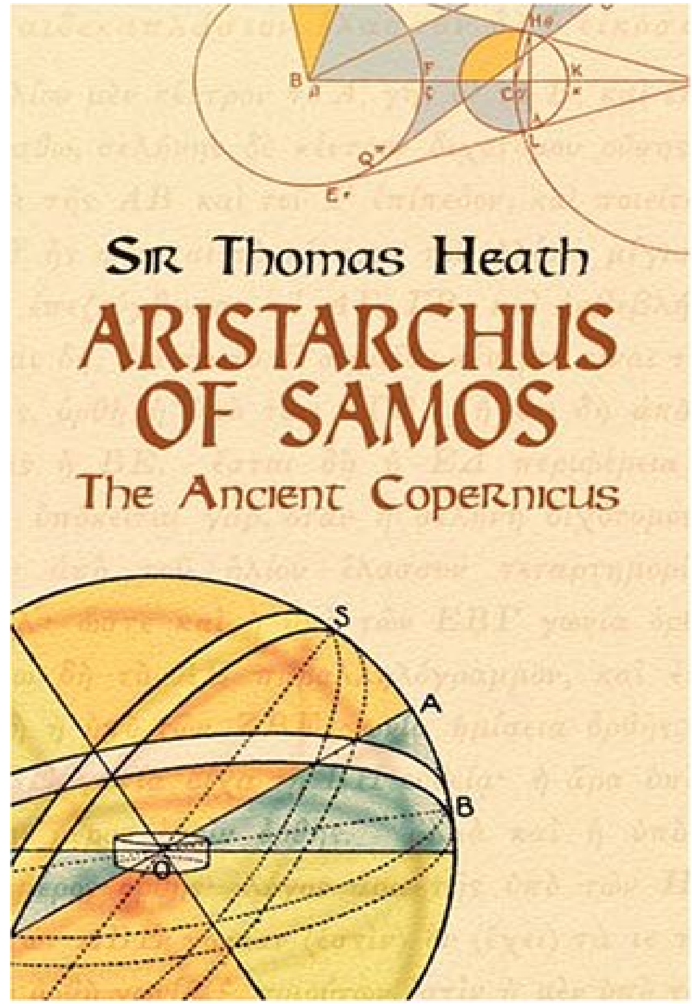
PROPAGAVIT

Daedalus 4.280.000

Daedalus is first mentioned by Homer as the creator of a wide dancing-ground for Ariadne. He also created the Labyrinth on Crete, in which the Minotaur was kept. Daedalus was shut up in a tower to prevent his knowledge of his Labyrinth from spreading to the public. He could not leave Crete by sea, as the king kept strict watch on all vessels. Daedalus set to work to fabricate wings for himself and his young son Icarus. When the work was done, the artist, waving his wings, found himself buoyed upward and hung suspended, poising himself on the beaten air. He next equipped his son in the same manner, and taught him how to fly. Daedalus warned Icarus not to fly too high, because the heat of the sun would melt the wax, nor too low, because the sea foam would soak the feathers. They had passed Samos and Delos by the time the boy, forgetting himself, began to soar upward toward the sun. The sun softened the wax which held the feathers together and they came off. Icarus fell in the sea and drowned. His father cried, and called the land near the place where Icarus fell into the ocean Icaria in memory of his child.

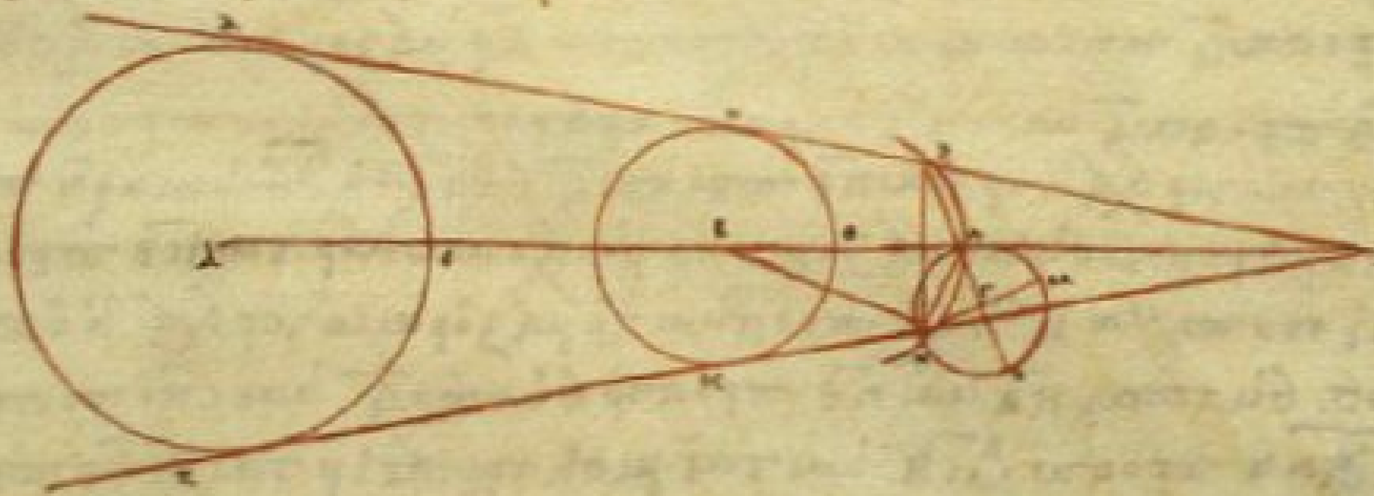




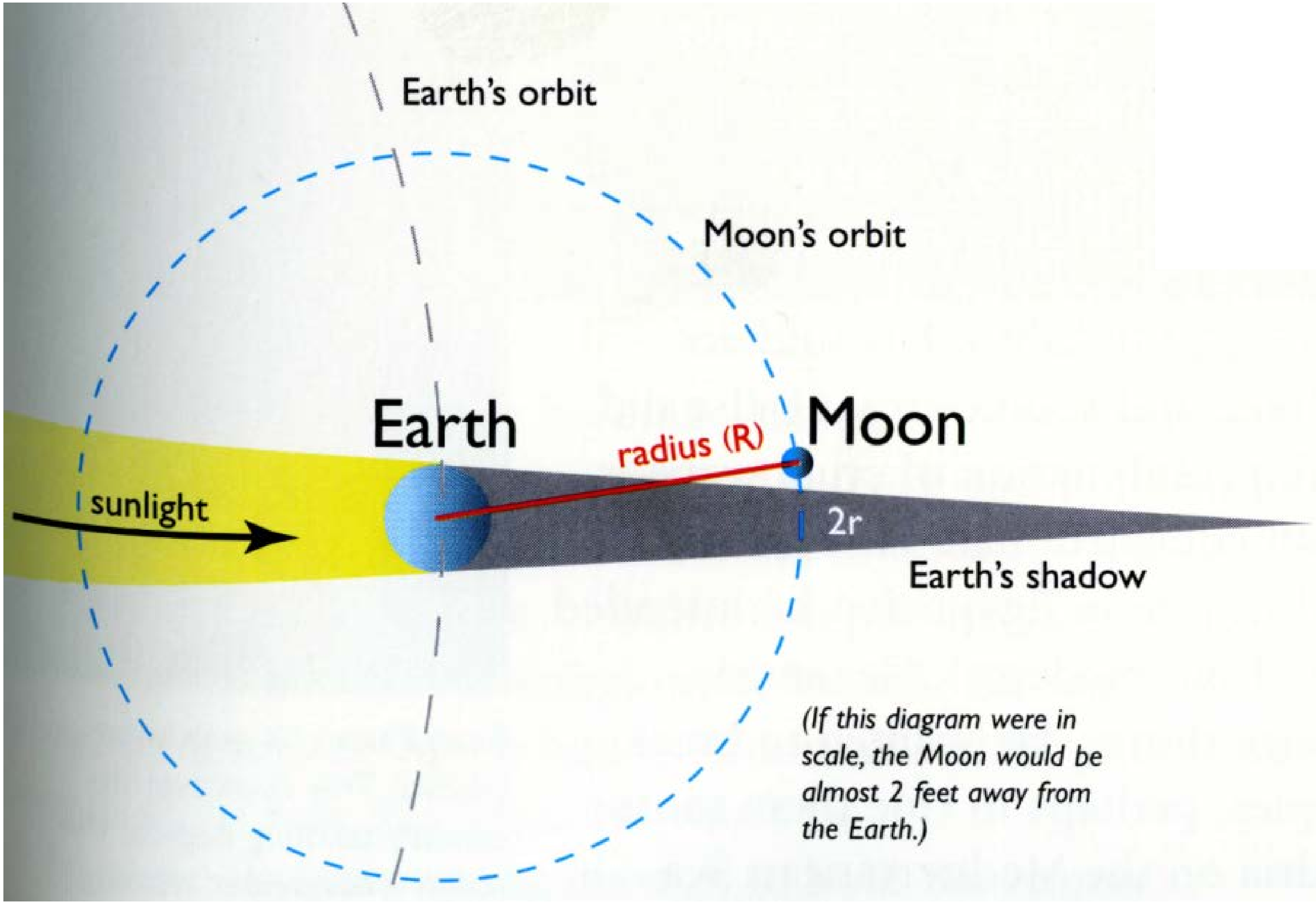
c. 310 – c. 230 BC

Aristarchus 569.000

το ͵βριφ πρὸς αὐτὸ τοῦ ἡλίου καὶ τὸν ϙ πρὸς ἔσται τὰ λοιπὰ τῆς διαμέτρου τοῦ
διορίζοντος ἐν τῇ σελήνῃ τό τε σκιερὸν καὶ τὸ λαμπρὸν τῆς δι-
αμέτρου τῆς σελήνης ἐλάσσων μέν ἐστιν ἢ β, μείζονα δὲ λόγον ἔχει
ἢ ὃν ταὐπη πρὸς με:



ὃν αὐτῶν ὑπὸ κα μὲν ... ἐκβληθεῖσα ἀπὸ τοῦ α τῇ αβ πρὸς ὀρθὰς ἡ
παράλληλος ὅτι ἡ ξν τῆς διαμέτρου τοῦ ἡλίου ἐλάσσων μέν ἐστιν ἢ ὁ
μέρος, μείζονα δὲ λόγον ἔχει πρὸς αὐτὴν ἢ ὃν τὰ ιβ πρὸς ψκε.


Earth's orbit
Moon's orbit
Earth
Moon
radius (R)
sunlight
2r
Earth's shadow
(If this diagram were in scale, the Moon would be almost 2 feet away from the Earth.)

We think the ancient astronomers may have waited patiently for a lunar eclipse. Then, they timed how long it took for the Moon to pass through Earth's shadow. The result led to a surprisingly close estimate of the Moon's distance. We can imagine how it might have been done.

Suppose Aristarchus pictured the Moon's orbit as a giant circle (it is, almost). Geometry being a strong suit, he saw that the distance from Earth to the Moon equals the radius of that large circle. So he labelled the distance with a capital R (see diagram at right).

It never fails; the circumference of every circle – including the Moon's orbit – is always $2\pi r$. Since π (pi) is about 3.14…, Aristarchus multiplied by 2 to get **6.28R**. The time it takes the Moon to cover that circumference (one orbit around Earth) is **T = 656 hours** (about 27 days).

To Aristarchus, it was obvious that the diameter of the Earth equals the diameter of its shadow. (It's actually smaller, but close enough.) During an eclipse, the Moon passes through that shadow. So he set the shadowed part of the Moon's orbit equal to **2r** (or I Earth diameter). Finally, a total lunar eclipse happened, and the Moon passed through Earth's shadow in about **t = 3 hours.**

Aristarchus now had all the numbers he needed. He knew that the ratio of a whole orbit (6.28R) to the shadow length (2r) is the same as the ratio of the whole orbit time (T) to the shadow time (t). Or:

$$\frac{6.28R}{2r} = \frac{T}{t}$$

Aristarchus entered the two times (T and t):

$$\frac{6.28R}{2r} = \frac{656 \text{ hours}}{3 \text{ hours}}$$

The rest was arithmetic:

$$\frac{6.28R}{2r} = 219$$

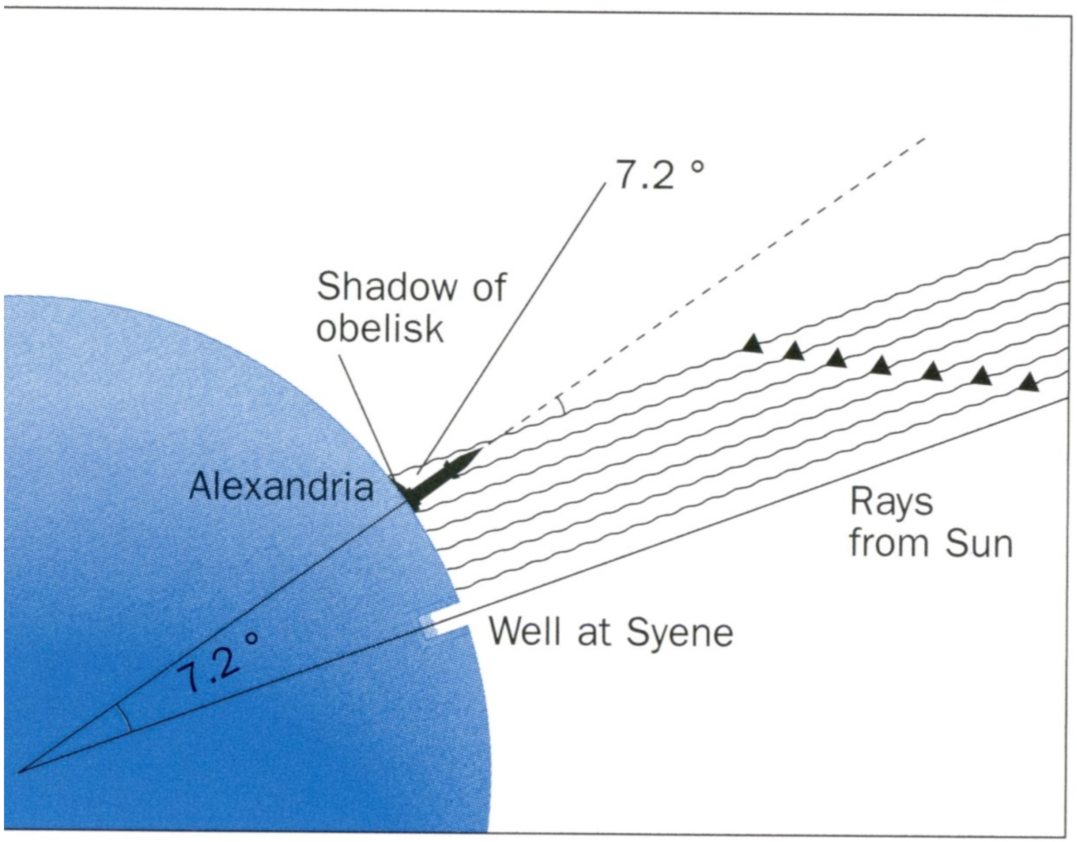
$$6.28R = 437r$$

$$R = 70r$$

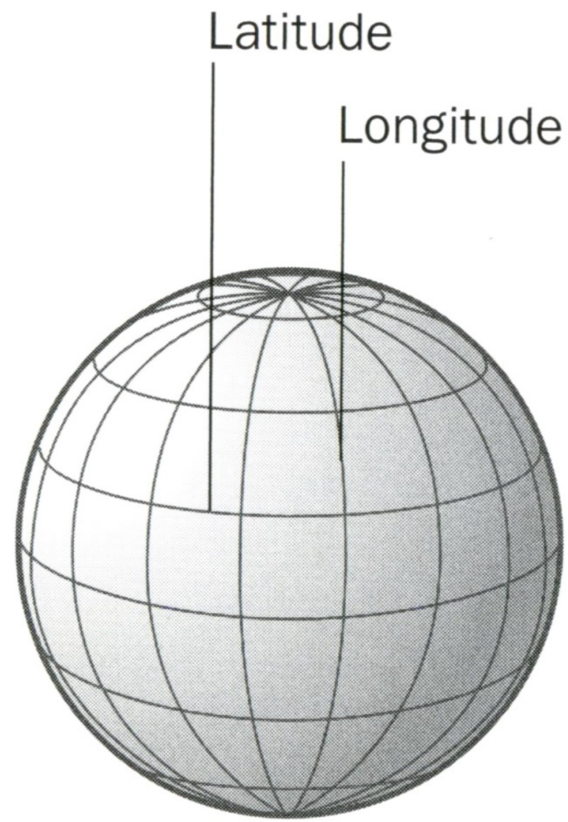
This simple equation meant that the distance to the moon (R) is about 70r-or 35 Earths in a row. We know now that it's closer to 60 radii, but that's not the point. Aristarchus did something no one else had done before, and he did long before lasers came around.

c. 276 BC – c. 195/194 BC

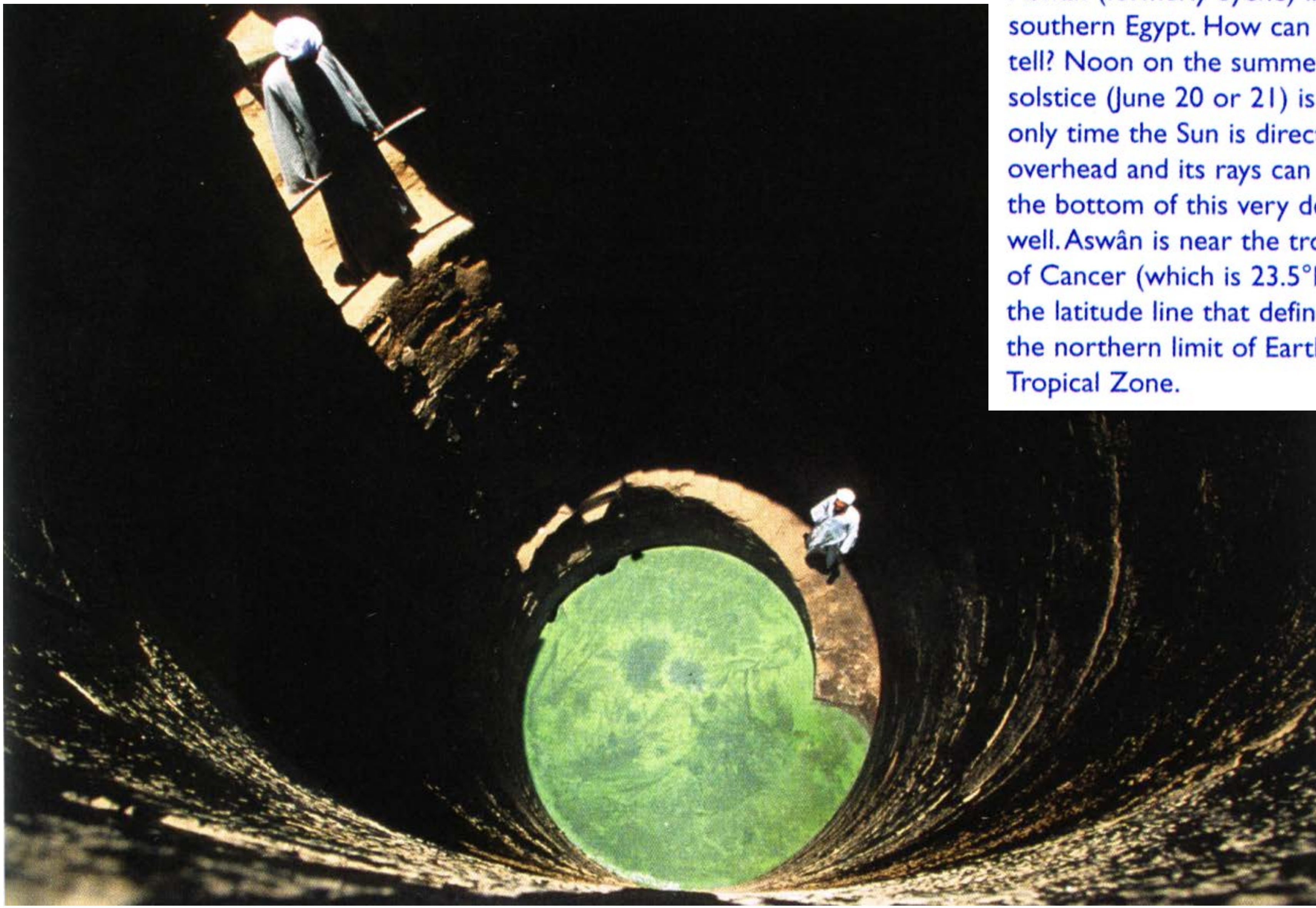
Eratosthenes is known as the Father of Geodesy (jee-OD-uh-see), the science of Earth measurement. Besides measuring the whole globe, he mapped the known world, from Britain to Ceylon and from the Caspian Sea to Ethiopia. He also made a star map with 675 stars, and he wrote a treatise on Greek comedy.



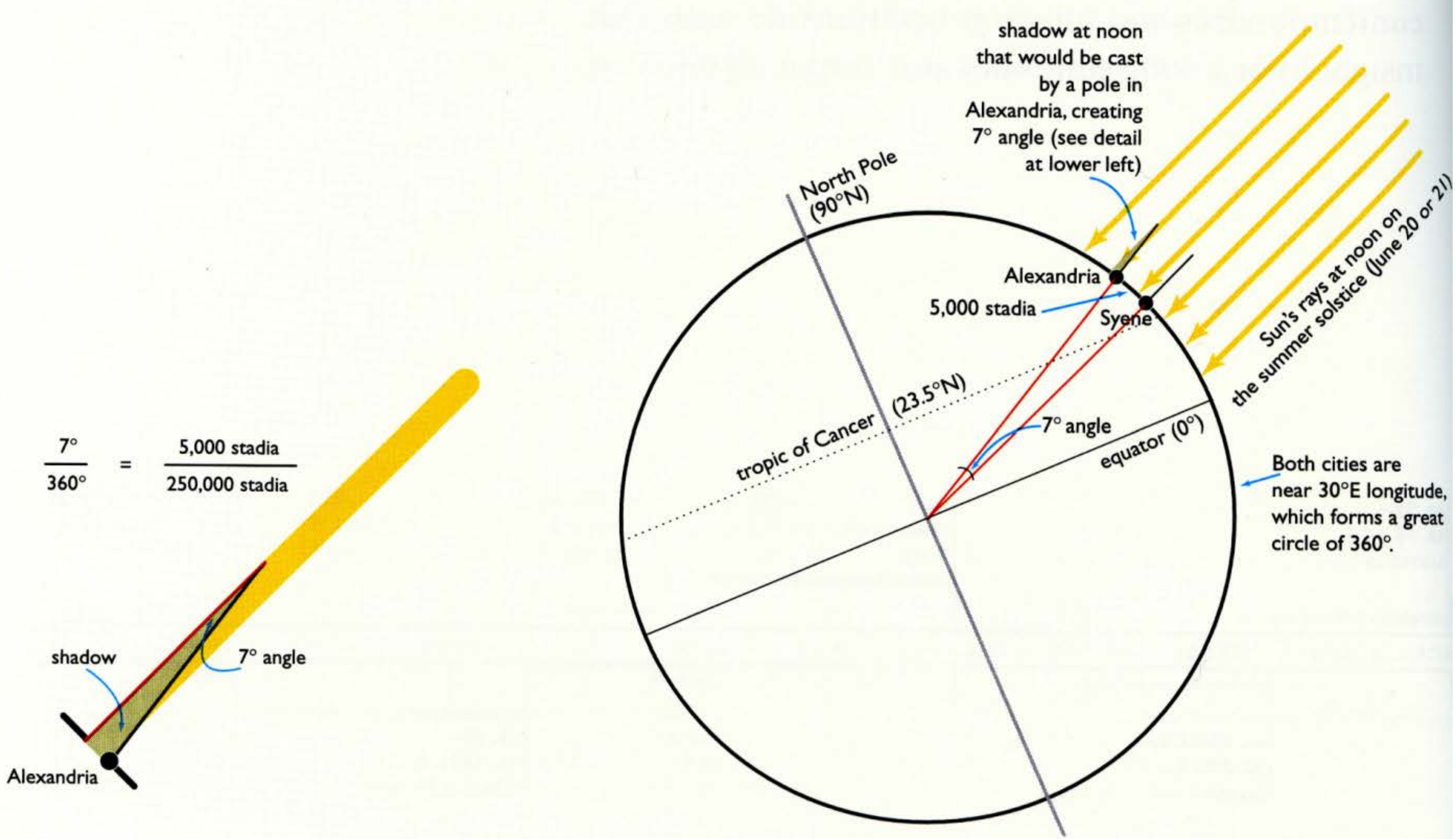
7.2 °
Shadow of
obelisk
Alexandria
Rays
from Sun
Well at Syene
7.2 °



Latitude
Longitude

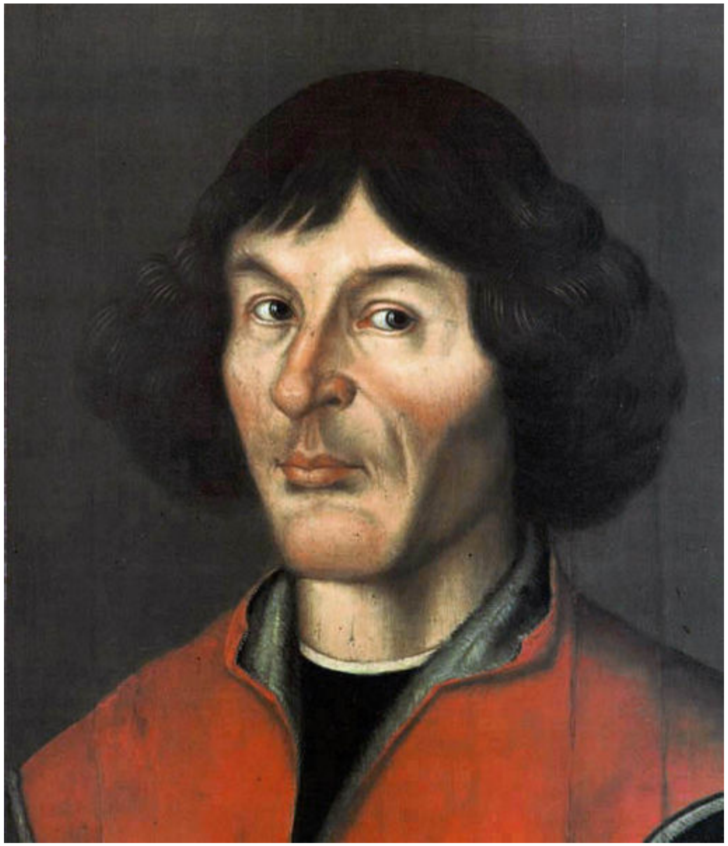


It's exactly noon in the city of Aswân (formerly Syene) in southern Egypt. How can you tell? Noon on the summer solstice (June 20 or 21) is the only time the Sun is directly overhead and its rays can reach the bottom of this very deep well. Aswân is near the tropic of Cancer (which is 23.5°N), the latitude line that defines the northern limit of Earth's Tropical Zone.

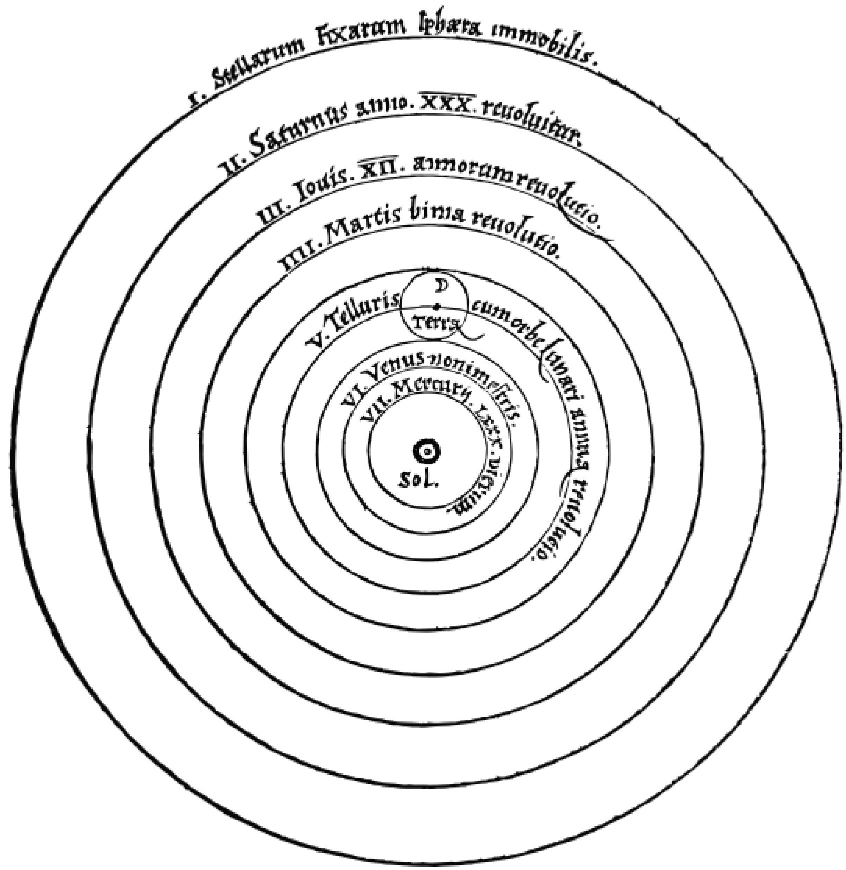


7° / 360° = 5,000 stadia / 250,000 stadia
shadow
7° angle
Alexandria
shadow at noon that would be cast by a pole in Alexandria, creating 7° angle (see detail at lower left)
North Pole (90°N)
Alexandria
5,000 stadia
Syene
Sun's rays at noon on the summer solstice (June 20 or 21)
tropic of Cancer (23.5°N)
7° angle
equator (0°)
Both cities are near 30°E longitude, which forms a great circle of 360°.

Nicolaus Copernicus
(1473 – 1543)

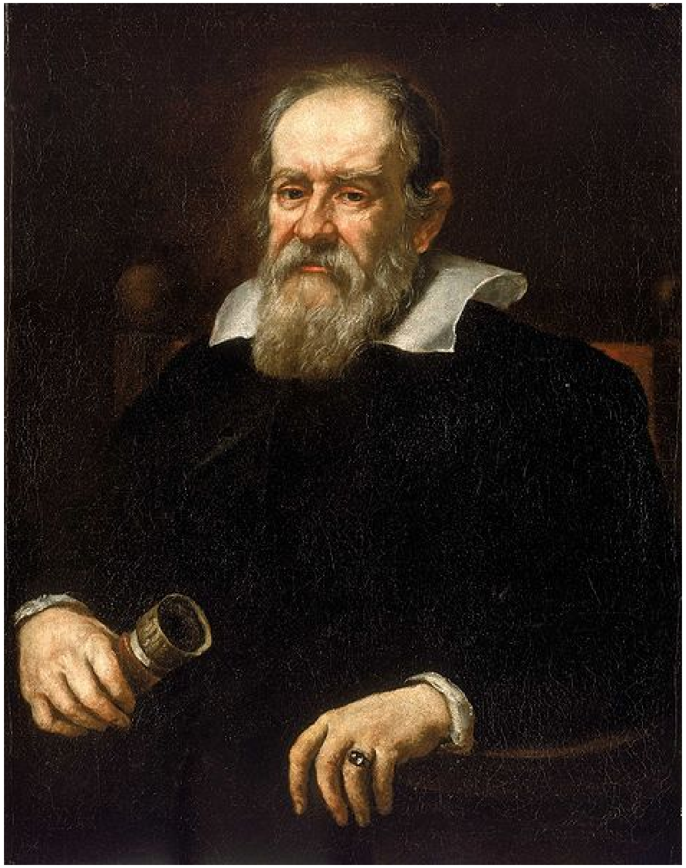


heliocentrism theory diagram



Copernicus 8.690.000

Galileo Galilei
(1564 – 1642)



Galilei 46.200.000

Tomasso Caccini
(1574 – 1648)

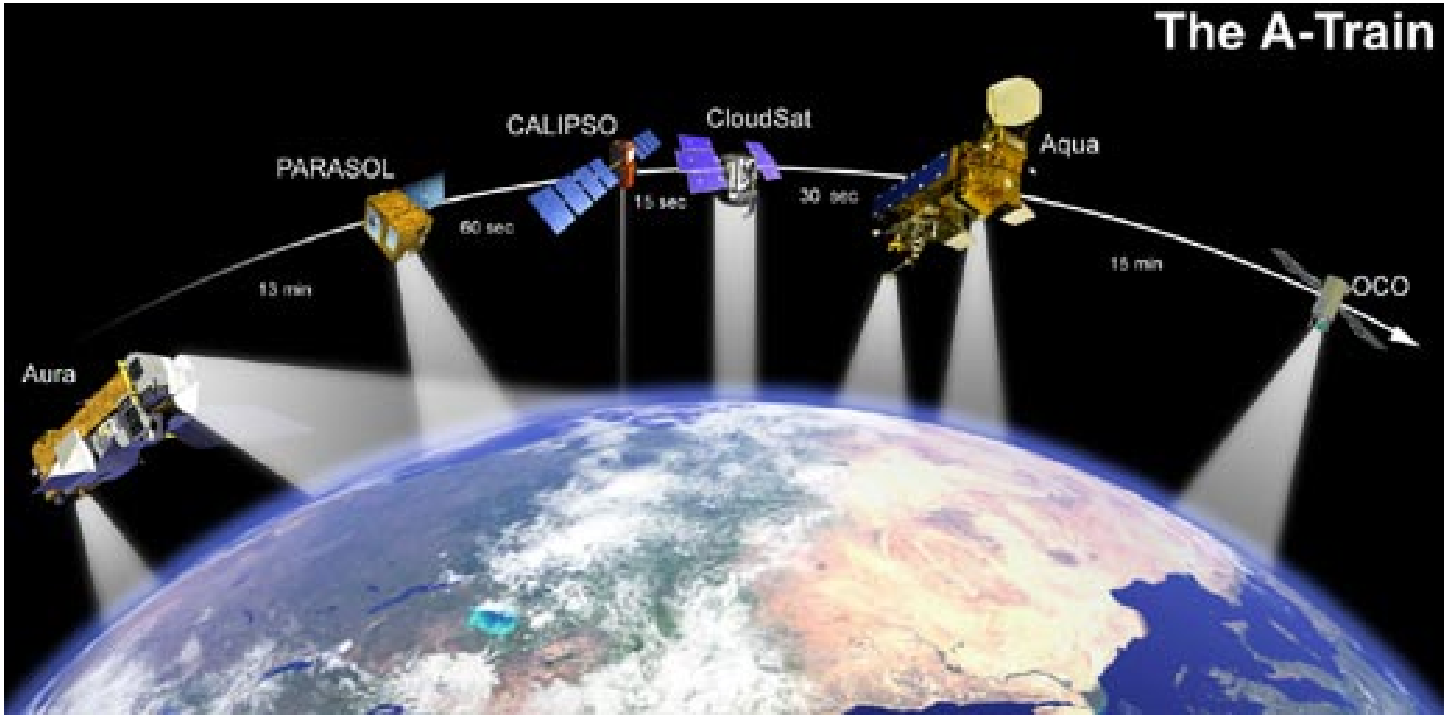
Father Tommaso Caccini, a Dominican monk and inveterate scandal-maker, was the chief instigator of Galileo's troubles. On December 20, 1614, Caccini preached a sermon in Florence that condemned mathematics and alleged that Copernicanism was either heretical or very close to it. Caccini, a "turbulent ignoramus," contended that Copernicus' Sun-centered system contradicted Scripture's description of an Earth-centered system.

In March of 1615, Caccini traveled to Rome and denounced Galileo before the Holy Office. In his deposition, Caccini claimed that Florence was full of "Galileists" who denied miracles, claimed God was an accident, and espoused Copernican views. Caccini's move was part of a plot calculated to force Rome to act against Galileo.

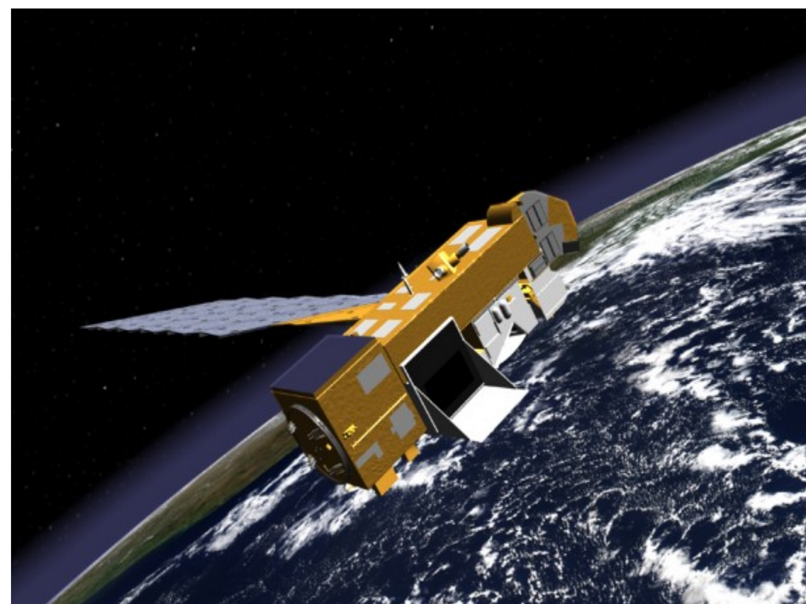
Galileo accurately sized up his enemy, describing Caccini as a person "of very great ignorance, no less a mind full of venom and devoid of charity." Caccini's own brother shared this appraisal, calling his sibling "a dreadful fool" whose "ugly drives" and "performance...makes no sense in heaven or earth."

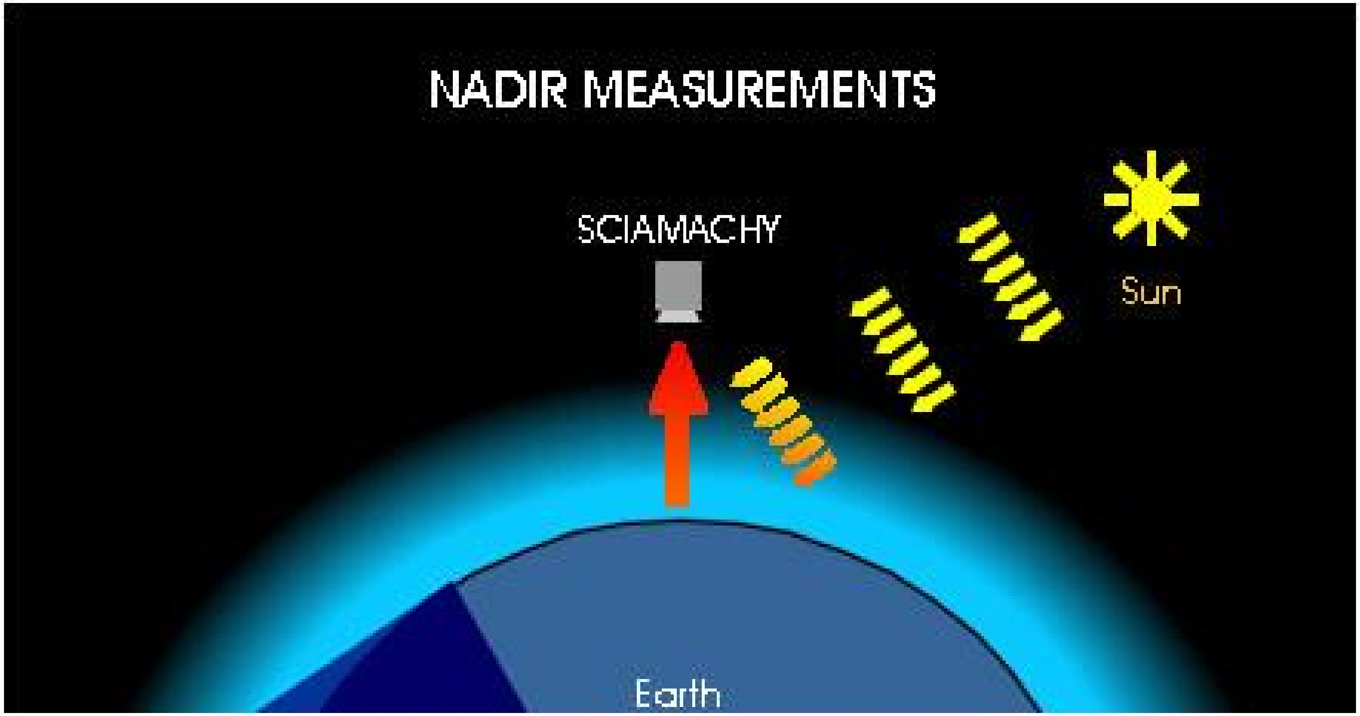
After playing his role in gaining Galileo's admonition in 1616, Caccini managed to earn the enmity of powerful Cardinal Borghese and was forced to leave Rome. He spent his later years as Prior of San Marco in Florence.

Caccini 12.300.000


The A-Train
PARASOL
CALIPSO
CloudSat
Aqua
Aura
OCO
13 min
60 sec
15 sec
30 sec
15 min

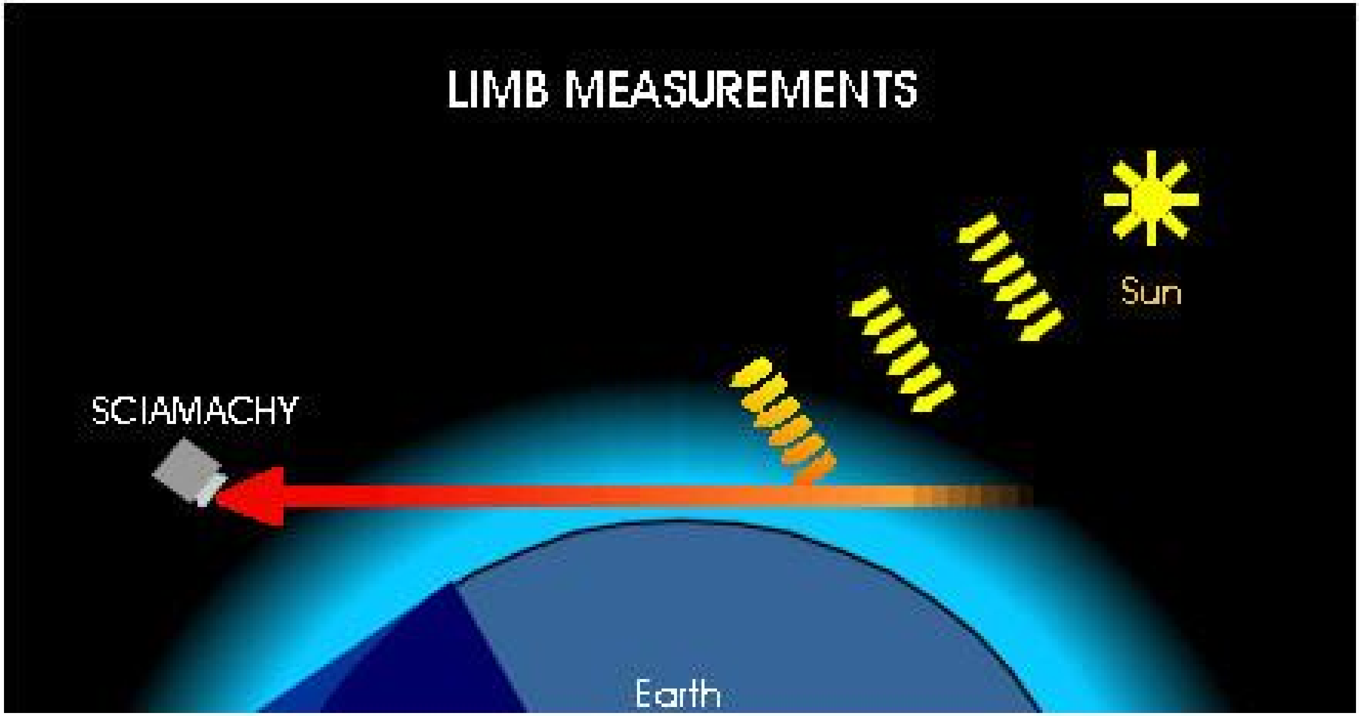

OMI





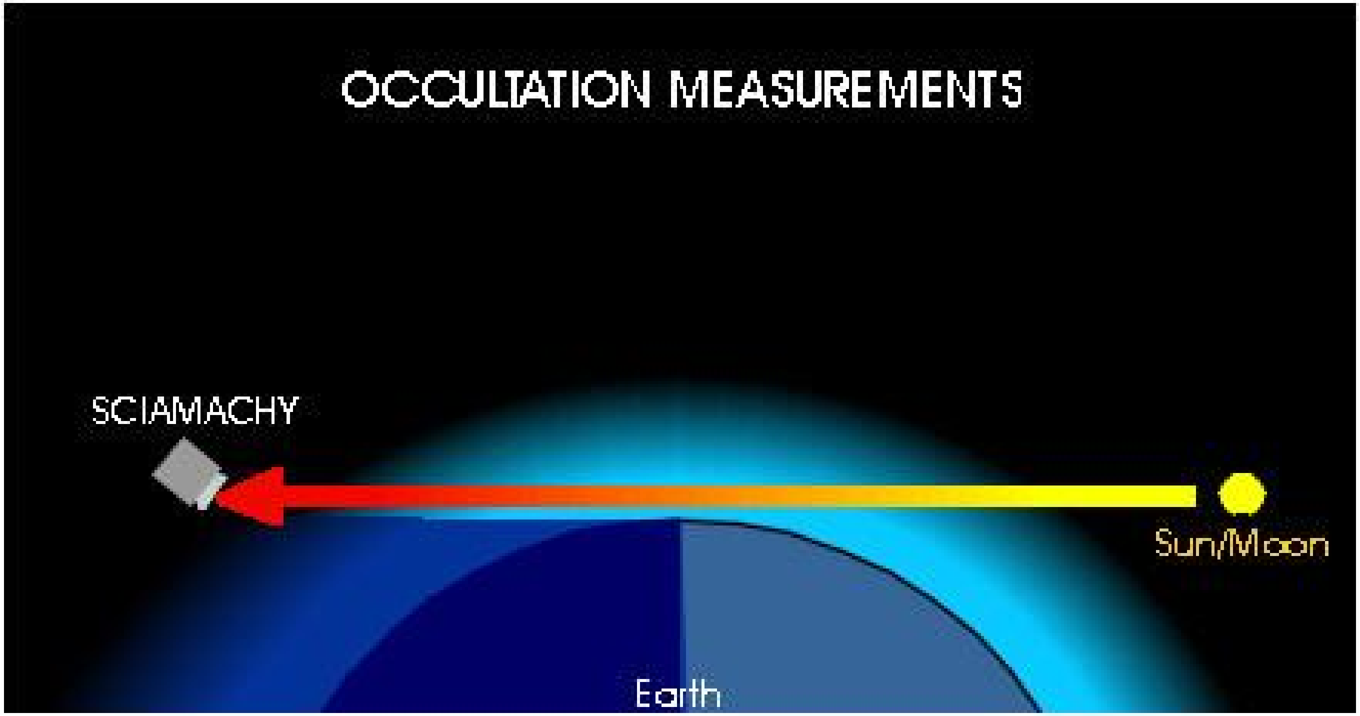
Nadir Geometry In Nadir mode the atmospheric volume directly under the instrument (i.e. the spacecraft) is observed. Each scan covers an area on the ground of up to 960 km across track with a maximum resolution of 26 km x 15 km.

Schiamachy 188.000



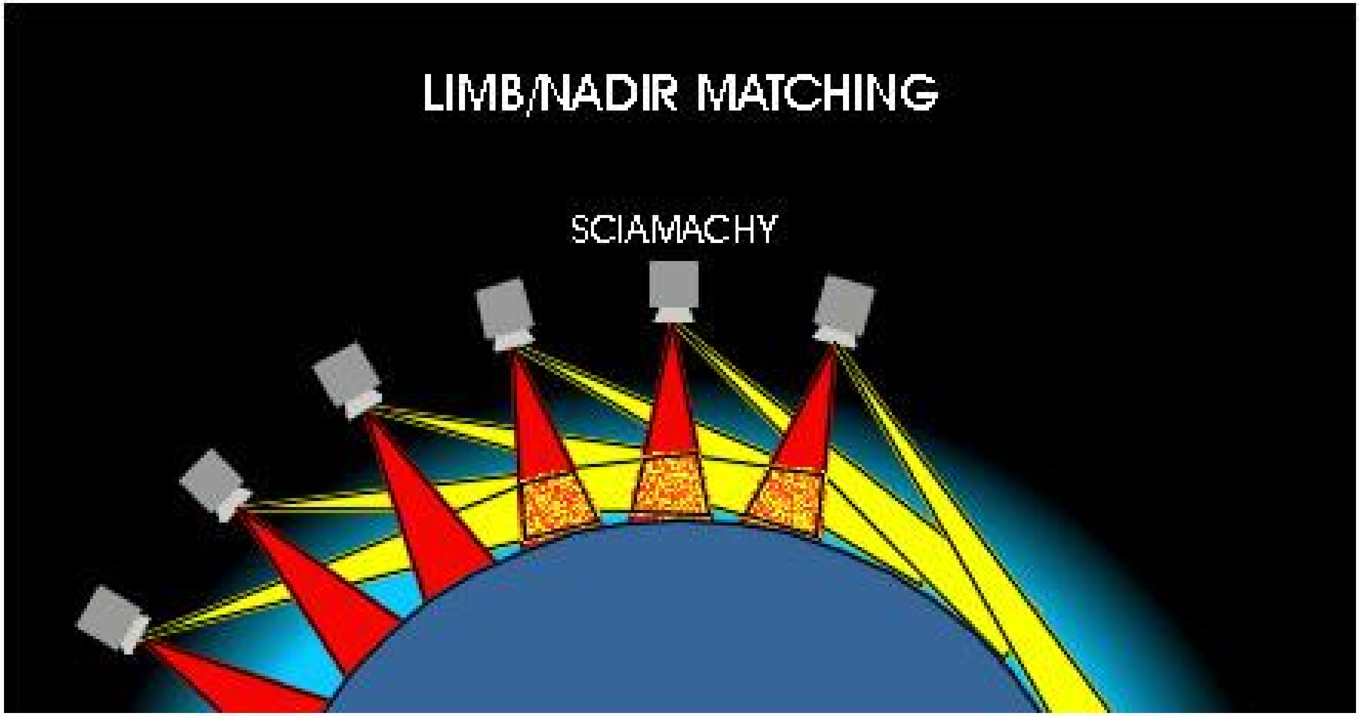
Limb Geometry In Limb mode the instrument looks at the edge of the atmosphere. Scans at different tangent altitudes over a range of up to 960 km in horizontal direction are performed with a geometrical vertical resolution of approximately 2.6 km.

Sciamachy 188.000



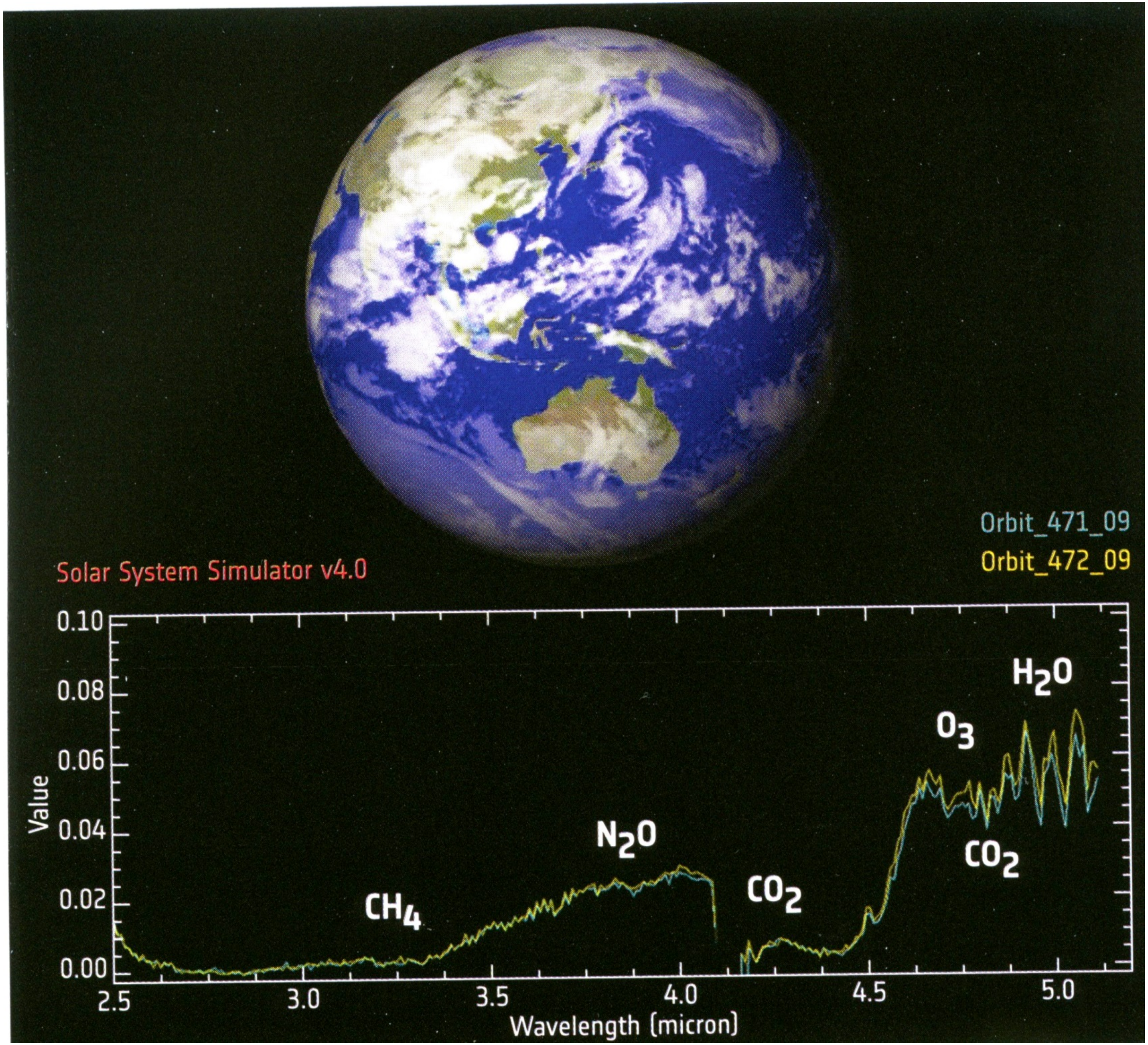
Occultation measurements are performed using the same geometry as in Limb mode, but with the sun or the moon in the instrument's field of view. Atmospheric densities are obtained by comparing measurements of the transmitted solar or lunar radiation with the unattenuated source. Solar occultation measurements are performed regularly during sunrise (latitude range 90° N - 65° N). Lunar occultation measurements during moonrise (between 30°S - 90°S) - which are possible for about one week per month - are used for process studies.

Sciamachy 188.000

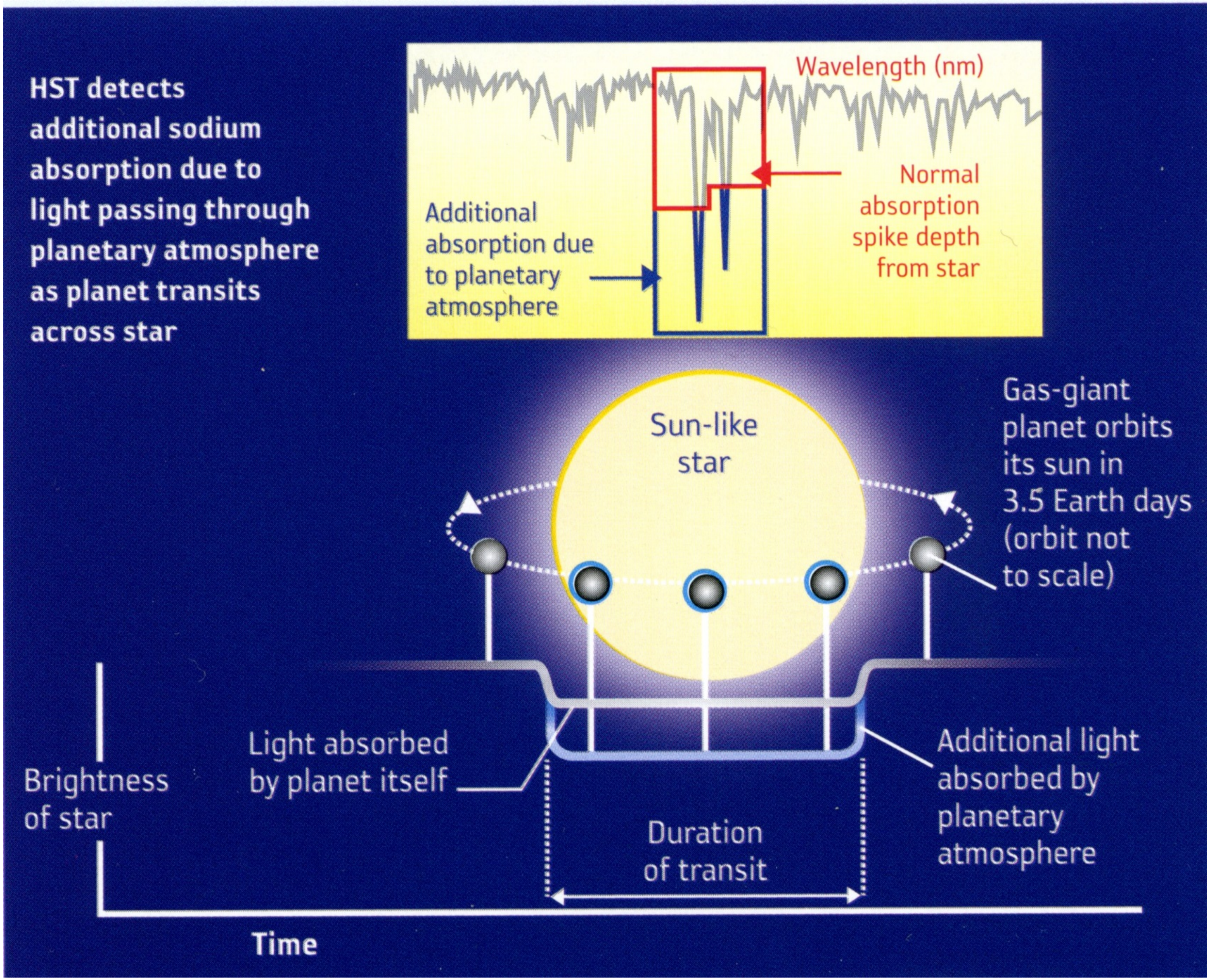


Limb / Nadir Matching One of the most important features of SCIAMACHY is the possibility to observe the same atmospheric volume first in limb and then after about 7 minutes in nadir geometry. By using this Limb/Nadir matching three-dimensional information about the atmosphere can be obtained.

Sciamachy 188.000



This image composite shows the signatures of methane (CH_4), carbon dioxide (CO_2), ozone (O_3) and nitrous oxide (N_2O), minor species of Earth's atmosphere but powerful greenhouse gases, detected by the Visual and Infrared Thermal Imaging Spectrometer (VIRTIS) on ESA's Venus Express at infrared wavelengths, while the spacecraft was pointing towards Earth along its orbit around Venus. These observations are relevant as they prove that a distant (extrasolar) planet can reveal to an instrument like VIRTIS the signatures of chemical compounds present in the atmosphere and on the surface. During these observations, Venus Express' distance from Earth was about 78 million km. (ESA/VIRTIS/INAF-IASF/Obs. de Paris-LESIA; Earth views: Solar System Simulator JPL-NASA)

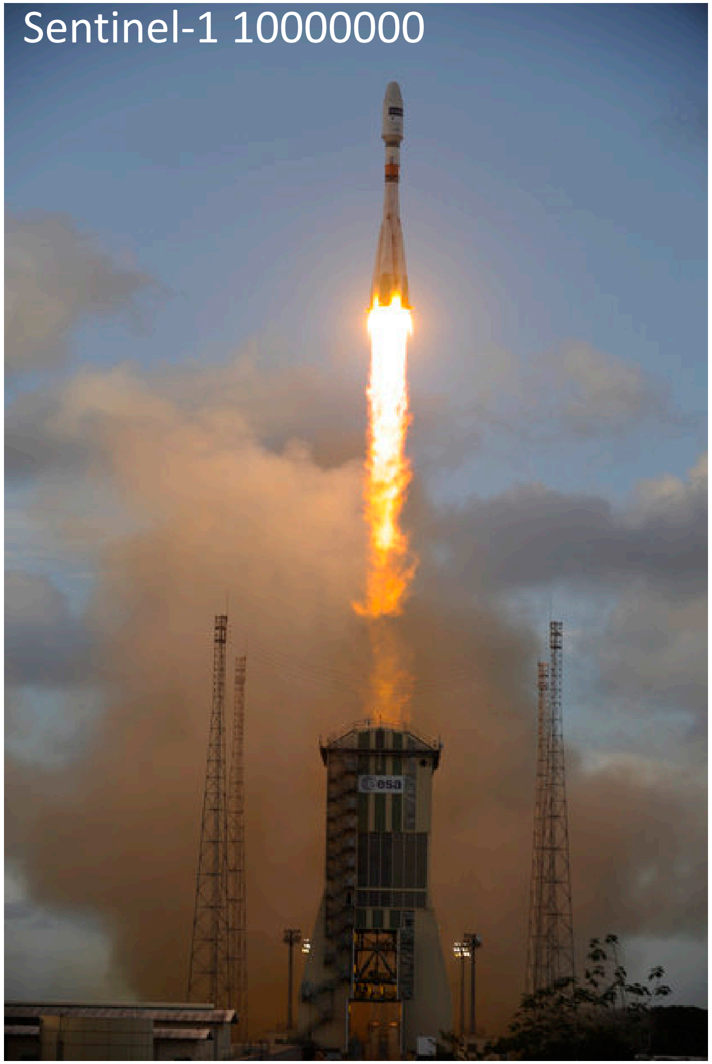


General technique for measuring the chemical composition of the atmospheres of eclipsing exoplanets. (SpaceRef.com)

Sentinel-1, the first in the family of Copernicus satellites, monitored many aspects of our environment, from detecting and tracking oil spills and mapping sea ice to monitoring movement in land surfaces and mapping changes in the way land is used. It also played a crucial role in providing timely information to help respond to natural disasters and assist humanitarian relief efforts.

Sentinel-1 10.000.000

Source ESA 2014



Soyuz VS07 with the ESA's Sentinel-1A satellite lifted off from Europe's Spaceport in Kourou, French Guiana, launced on 3rd April 2014.

Acquired on 13 April 2014 at 23:57 GMT (14 April at 01:57 CEST) by Sentinel-1A, this image shows a transect over the northern part of the Antarctica Peninsula.

Source ESA 2014

Sentinel-5 60.000.000

The Sentinel-4 and Sentinel-5 missions are dedicated to monitoring the composition of the atmosphere for Copernicus Atmosphere Services. Both missions will be carried on meteorological satellites operated by Eumetsat.

To be carried on the geostationary Meteosat Third Generation satellites, the Sentinel-4 mission comprises an Ultraviolet Visible Near-infrared (UVN) spectrometer and data from Eumetsat's thermal InfraRed Sounder (IRS), both embarked on the MTG-Sounder (MTG-S) satellite. After the MTG-S satellite is in orbit, the Sentinel-4 mission also includes data from Eumetsat's Flexible Combined Imager (FCI) embarked on the MTG-Imager (MTG-I) satellite.

To be carried on the polar-orbiting MetOp Second Generation satellite, the Sentinel-5 mission comprises an Ultraviolet Visible Near-infrared Shortwave (UVNS) spectrometer and data from Eumetsat's IRS, the Visible Infrared Imager (VII) and the Multi-viewing Multi-channel Multi-polarization Imager (3MI).

In addition, a Sentinel-5 Precursor mission is being developed to reduce data gaps between Envisat, in particular the Sciamachy instrument, and the launch of Sentinel-5. As a joint initiative between ESA and the Netherlands the mission will comprise a satellite and a UVNS instrument called Tropomi.

The Sentinel-4 and -5 missions will provide information on atmospheric variables in support of European policies. Services will include the monitoring of air quality, stratospheric ozone and solar radiation, and climate monitoring.