Transit of Venus

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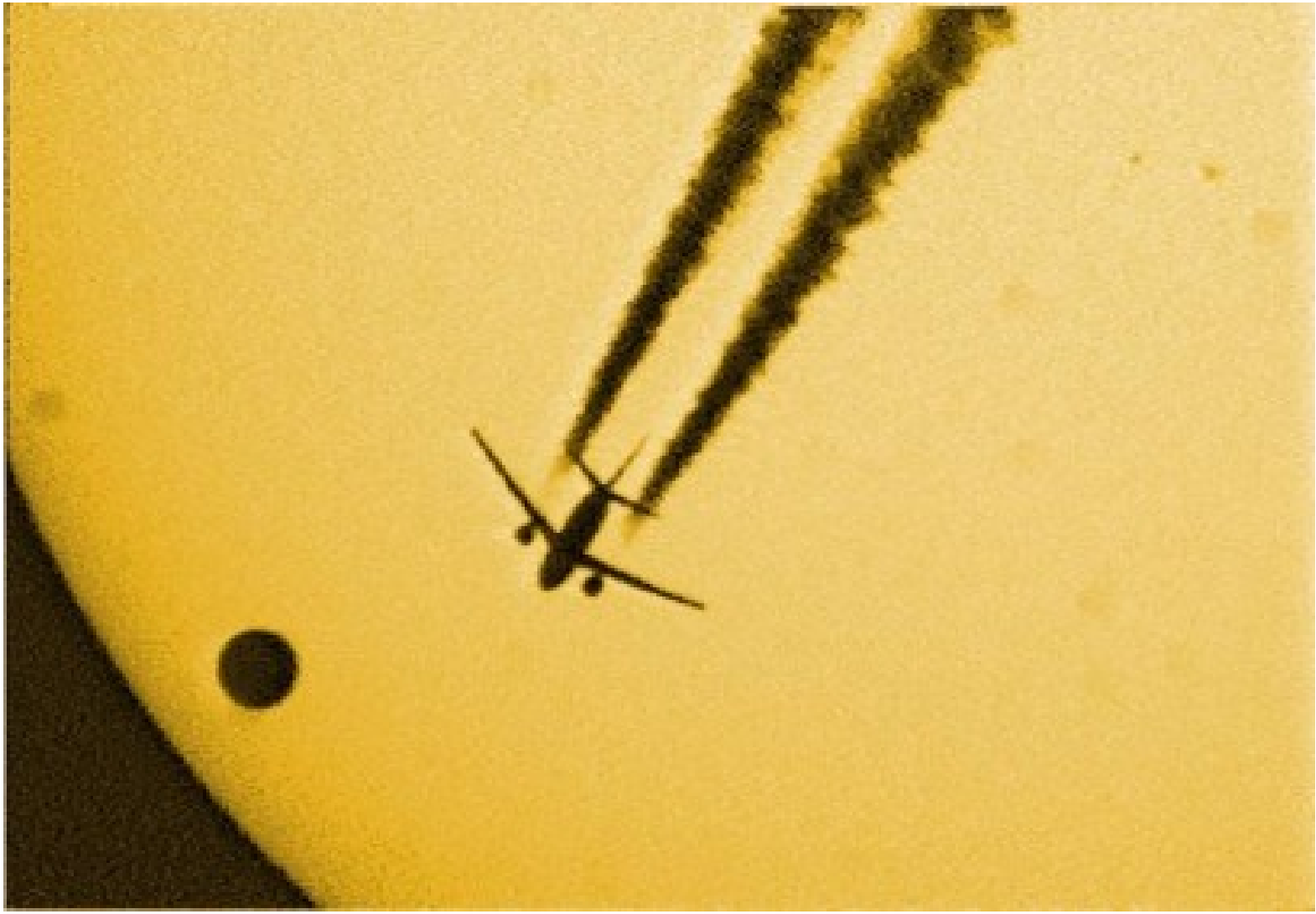
Transit of Venus

z = 0, Γ= 1, why would anyone care?



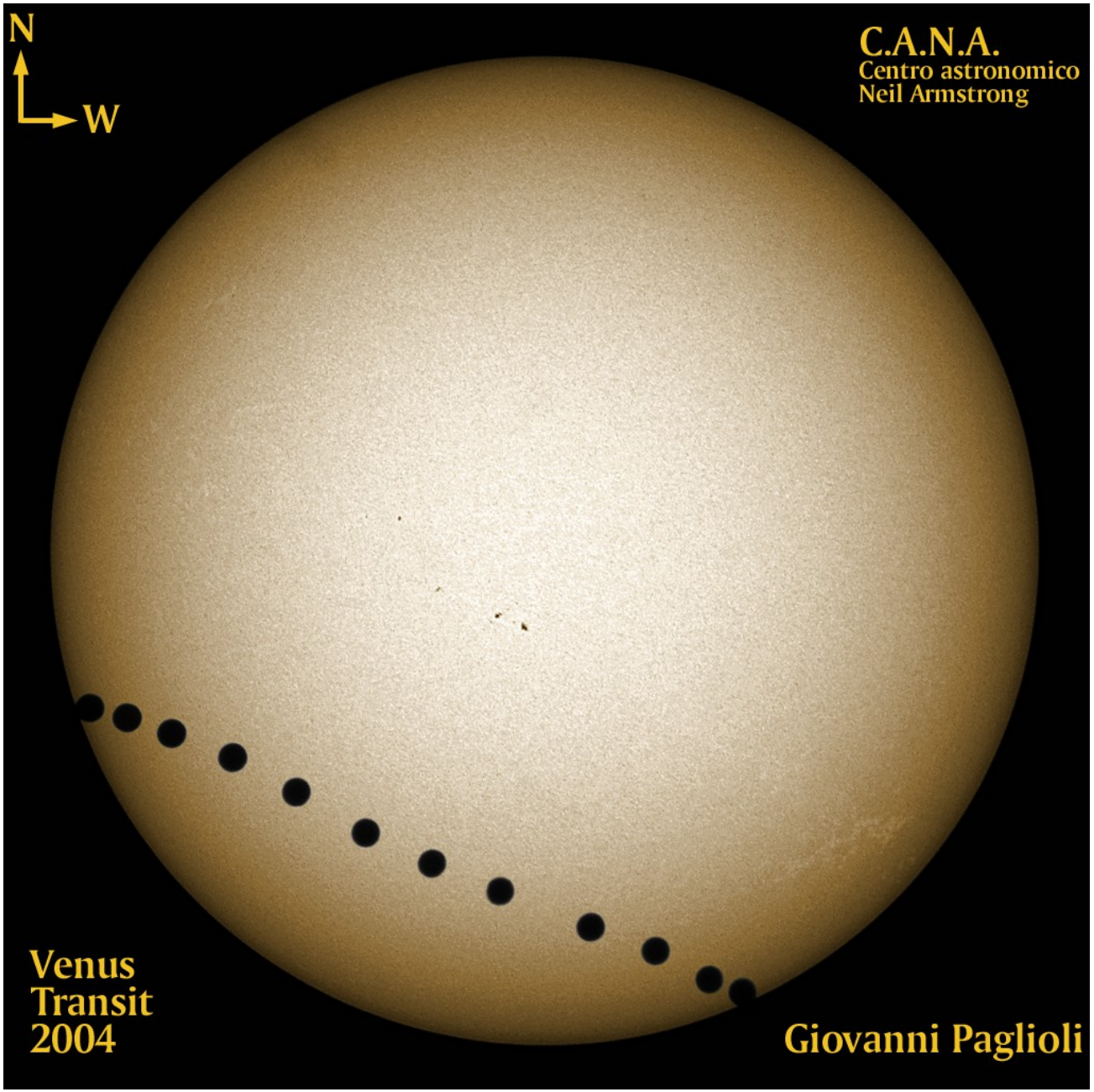
Transit of Venus

- Background
- (Brief) History
- Tonight's science
- Viewing event

Basics

Basics of transit

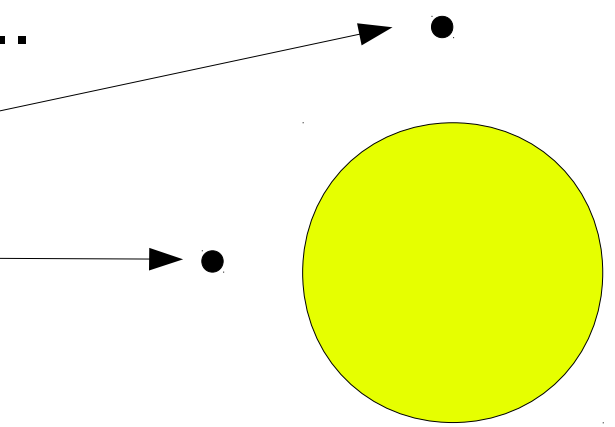
8, 105.5,
8, 121.5,
8, 105.5,
8, 121.5,
8, 105.5,
8, 121.5,
8, 105.5,
8, 121.5, ...

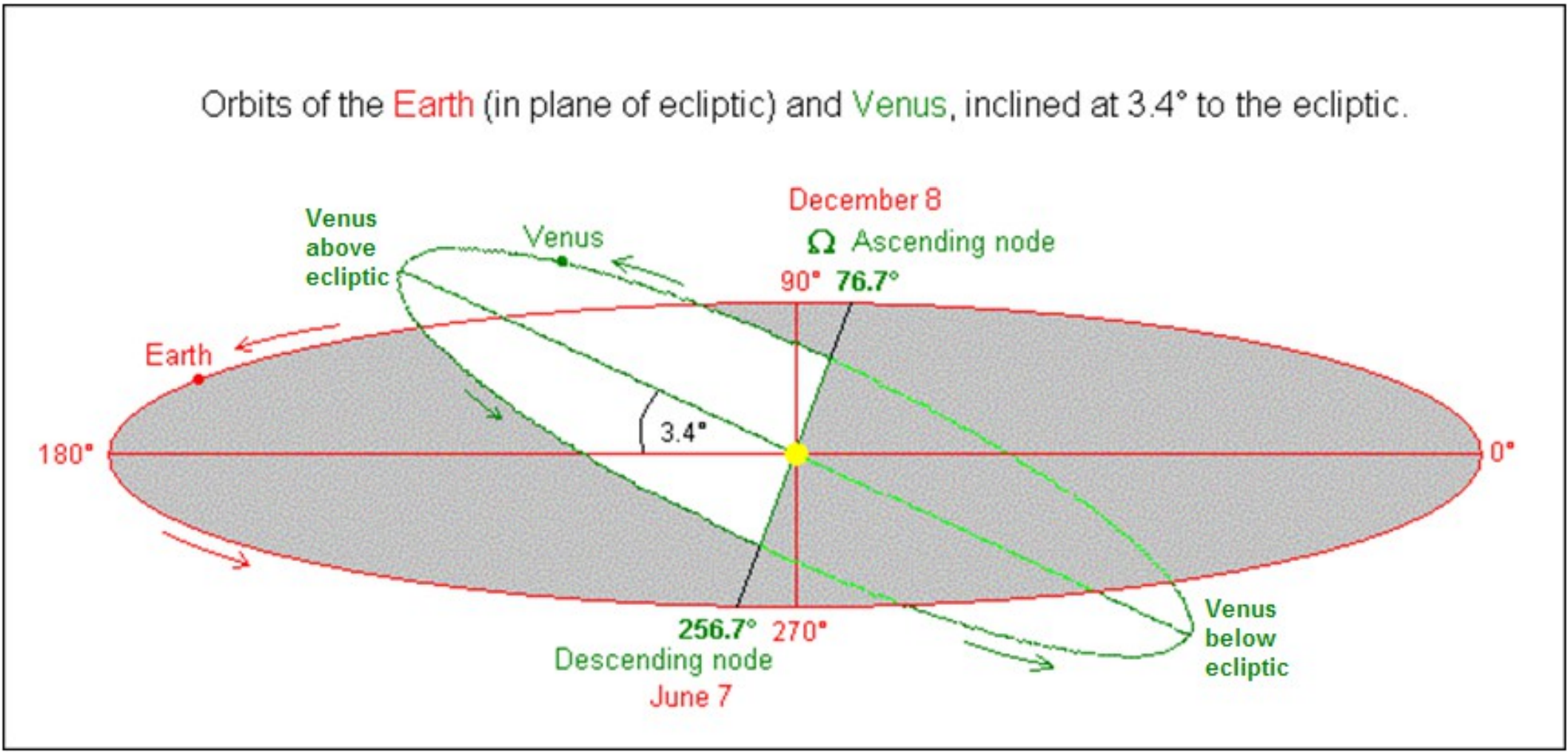


Basics of transit

- Planet between ⊕ & ⊙

- The three bodies have to be in line ...
  - east-west: inferior conjuction
  - north-south: close to a node



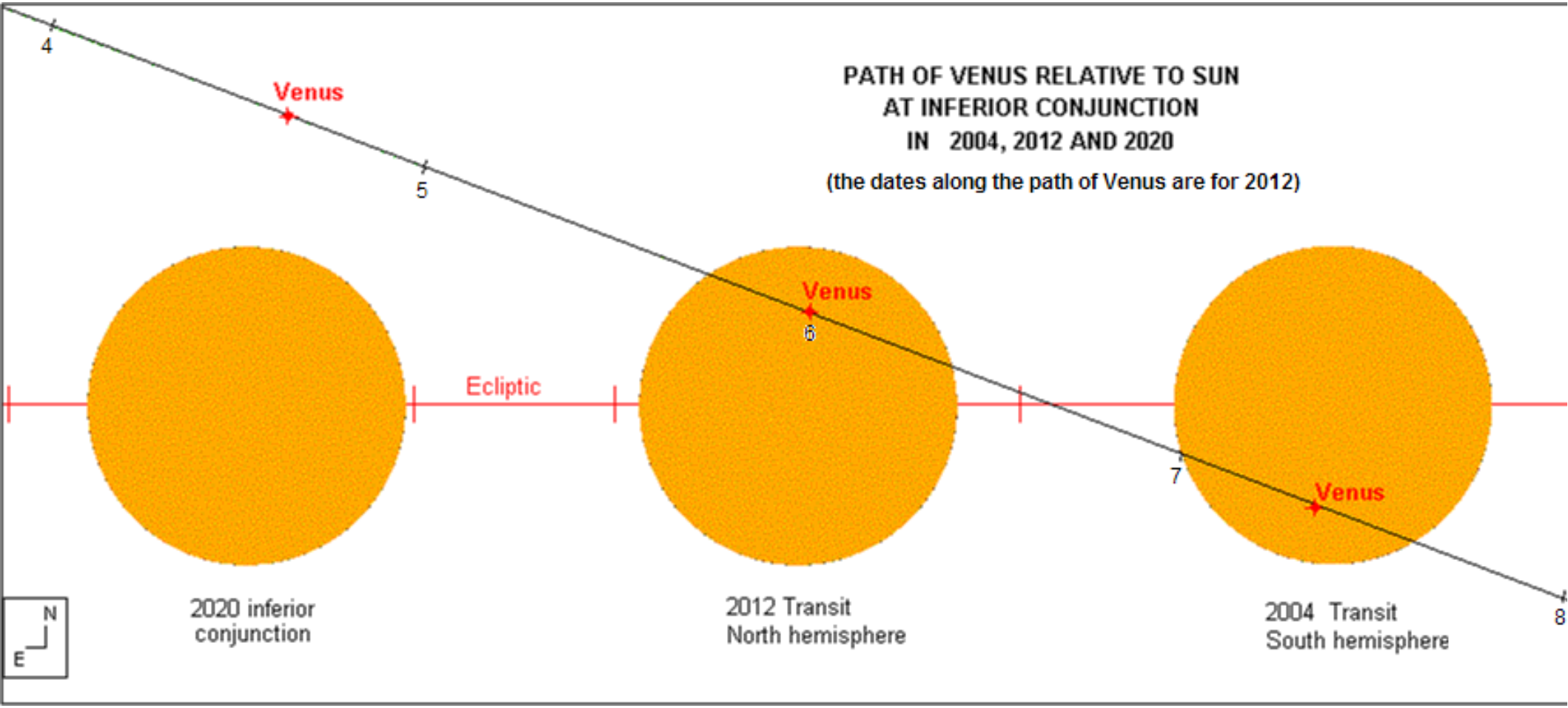

Orbits of the Earth (in plane of ecliptic) and Venus, inclined at 3.4° to the ecliptic.
December 8
Ω Ascending node
90° 76.7°
Venus
Venus above ecliptic
Earth
3.4°
180°
0°
256.7° 270°
Descending node
June 7
Venus below ecliptic

Basics of transit

- Planet between ⊕ & ⊙

- The three bodies have to be in line ...
  - east-west: inferior conjuction
  - north-south: close to a node

- I.e. V needs to be a node during a conjunction.
- 8, 105.5, 8, 121.5, 8, 105.5, 8, 121.5, ...



Inferior conjunctions near a node:

2004: Venus at the node	~ 12 h late	→	transit
2012:	~ 10 h early	→	transit
2020:	~ 2 days early	→	no transit

History

Developing tools & concepts

- 1631 & 1639: Theoretical prediction, Telescope
- 1761 & 1769: Pendulum clock
- 1874 & 1882: Photography, Spectroscopy
- 2004 & 2012: Internet, Satellites, Exoplanets
- 2117 & 2125: ?

Historical discoveries

(*Previously, in astronomy*: Copernicus, Brahe;
currently hot: Kepler, Galilei, et al.; → **scientific revolution**)

- 1631: Kepler predicted the transit, but wasn't observed.
- 1639: Horrocks reworked Kepler's data and found an oncoming transit (in a month!).

  Observed for the first time (ever).

Historical discoveries

- 1631: Kepler predicted the transit.
- 1639: Horrocks's first observation.
- Late 1600s, early 1700s: Transit can be used to determine distances to Venus and Sun, if observed from different places

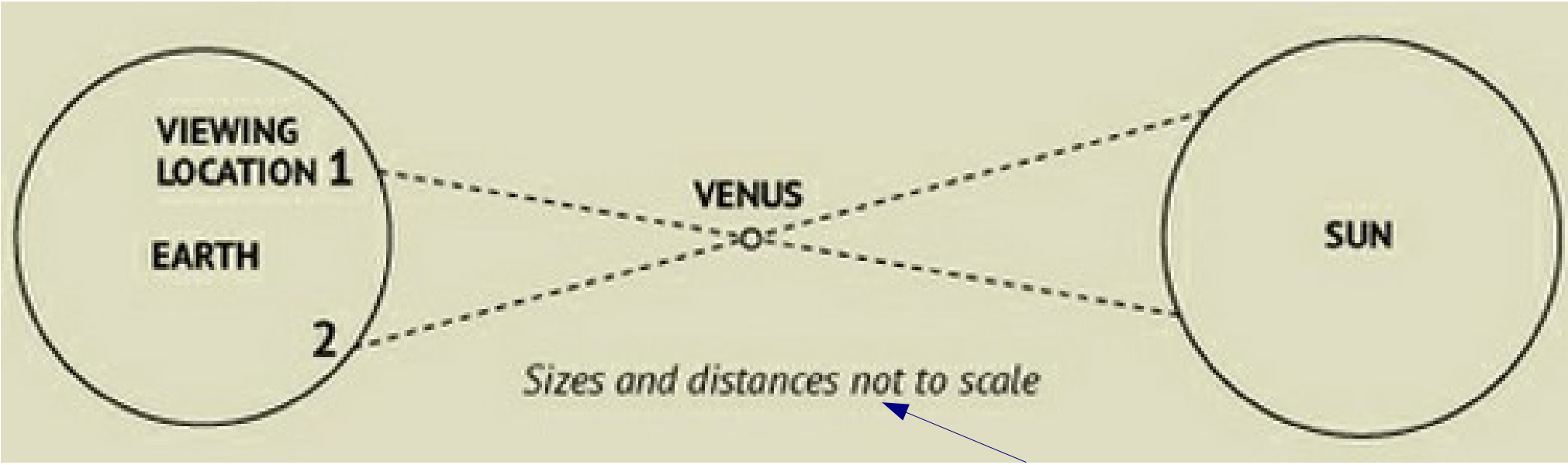
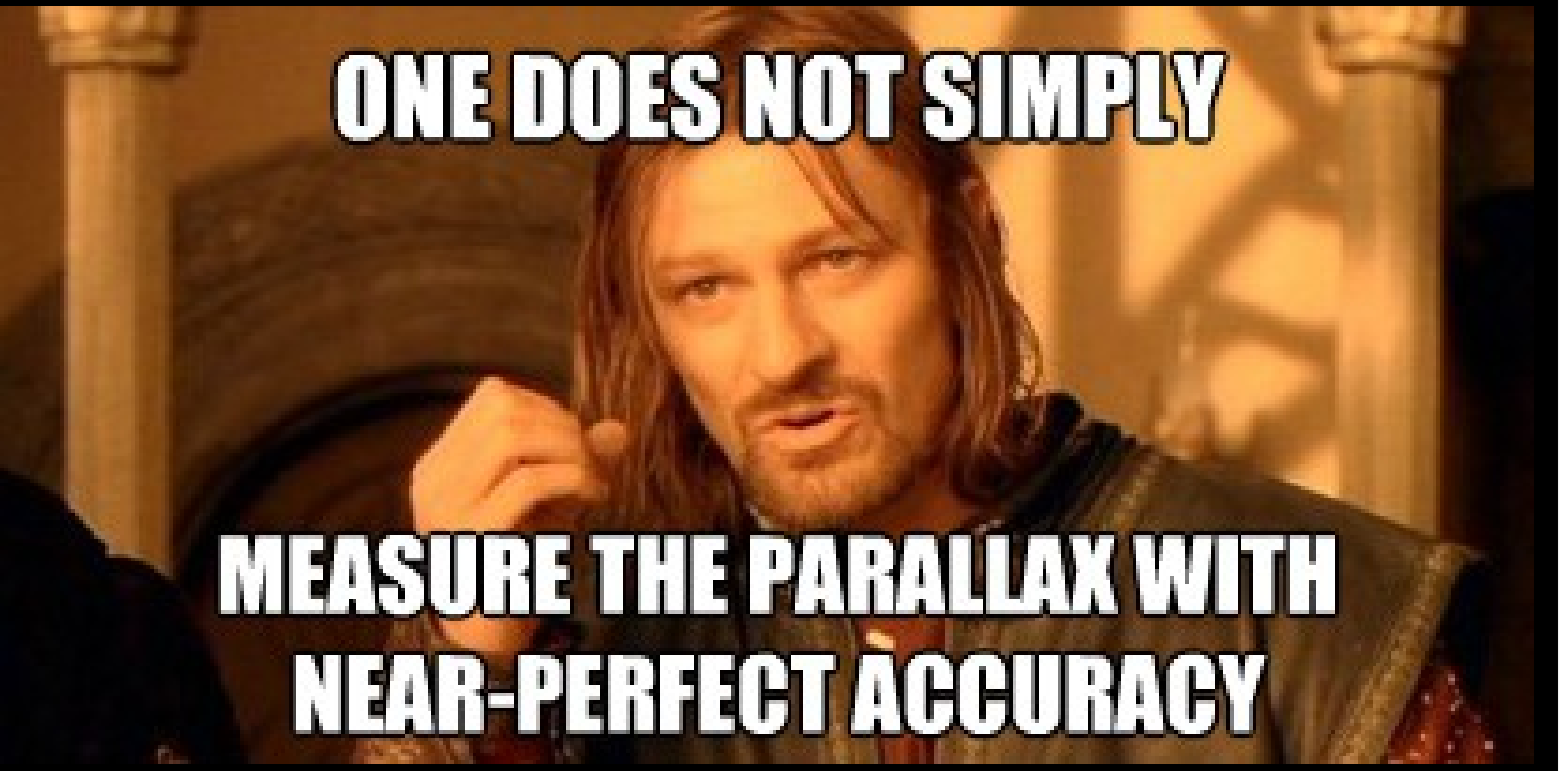


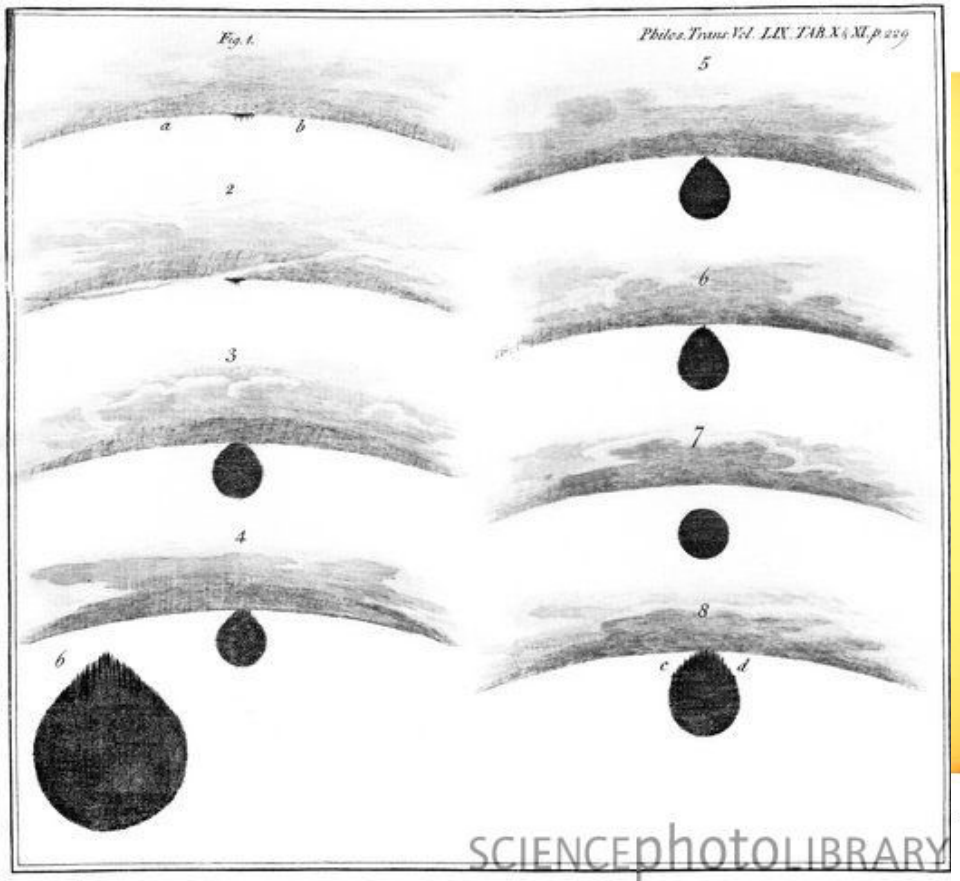
Image taken from an American popular science article...

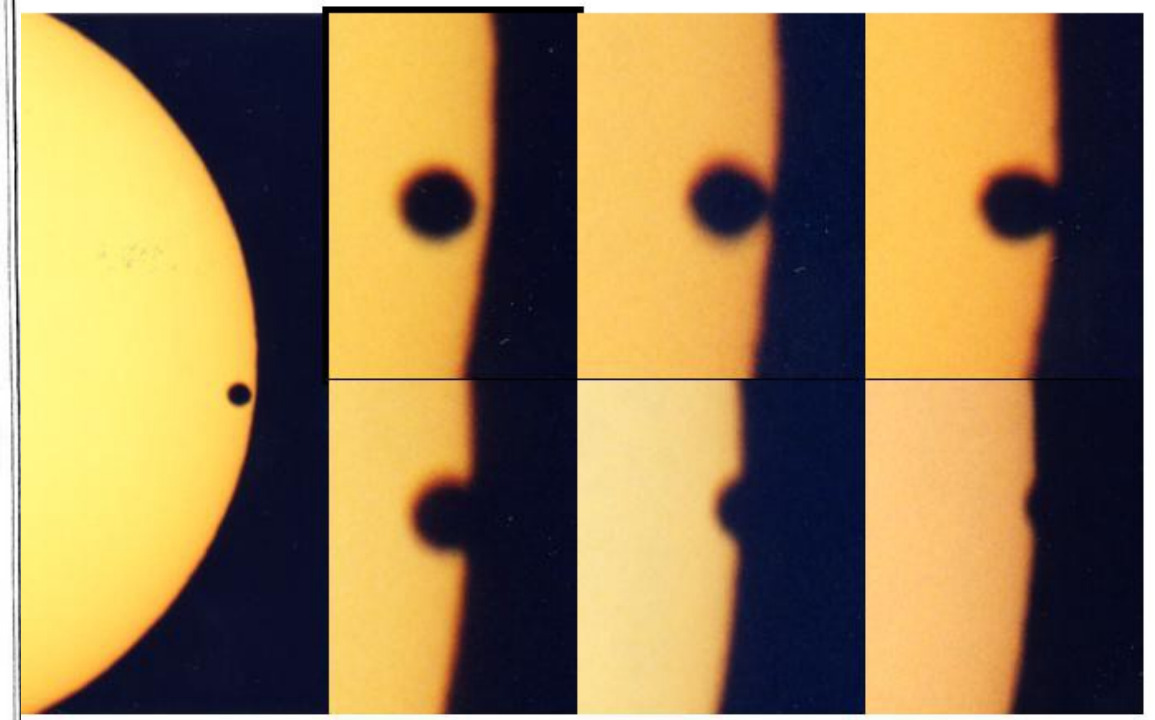
→ national expeditions to remote places for the next transits. Determining the parallax ”with near-perfect accuracy.”


ONE DOES NOT SIMPLY
MEASURE THE PARALLAX WITH
NEAR-PERFECT ACCURACY

Historical discoveries

- 1631: Kepler predicted the transit.
- 1639: Horrocks's first observation.
- 1761 & 1769: Expeditions sent to ”the ends of the Earth”
  - Disappointments: The Black Drop distorted exact timing





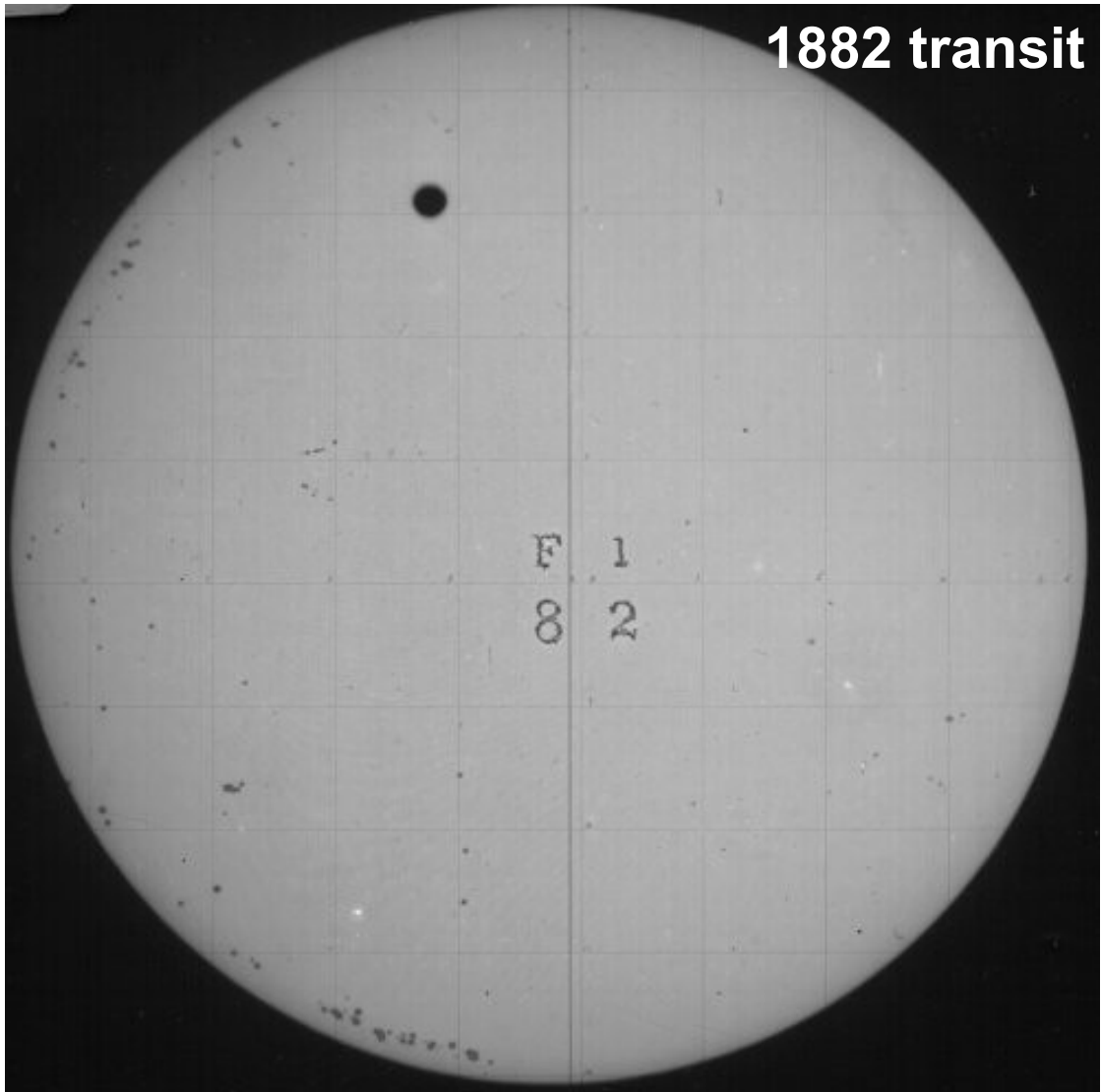
Transit of Venus: C11 @ Prime Focus, f/10, Solar Filter, Kodak 400

Historical discoveries

- 1631: Kepler predicted the transit.
- 1639: Horrocks's first observation.
- 1761 & 1769: Expeditions sent to ”the ends of the Earth”
  - Disappointments: The Black Drop distorted exact timing
  - Nevertheless: Scale of the Solar system narrowed down:
    1 AU = 153 Gm (2.3 % error)
  - Lomonosov (1761): halo around Venus's disk
    → other planets with atmospheres

Historical discoveries

- 1631: Kepler predicted the transit.
- 1639: Horrocks's first observation.
- 1761 & 1769: Expeditions
  - 1 AU = 153 Gm
  - Atmosphere of Venus
- 1874 & 1882: Improved optics, photography
  - 1 AU = 149,33 Gm (0.18 % error)



Historical discoveries

- 1631: Kepler predicted the transit.
- 1639: Horrocks's first observation.
- 1761 & 1769: Expeditions sent to ”the ends of the Earth”
  - 1 AU = 153 Gm
  - Atmosphere of Venus
- 1874 & 1882: First photographs
  - 1 AU = 149.33 Gm (0.18 % error)
- 2004: Internet, Satellites, knowledg of exoplanets
  - E.g. VT-2004; 2763 participants (including ~1000 schools, 149.609 Gm, 0.007 %)

2012 transit

Examples

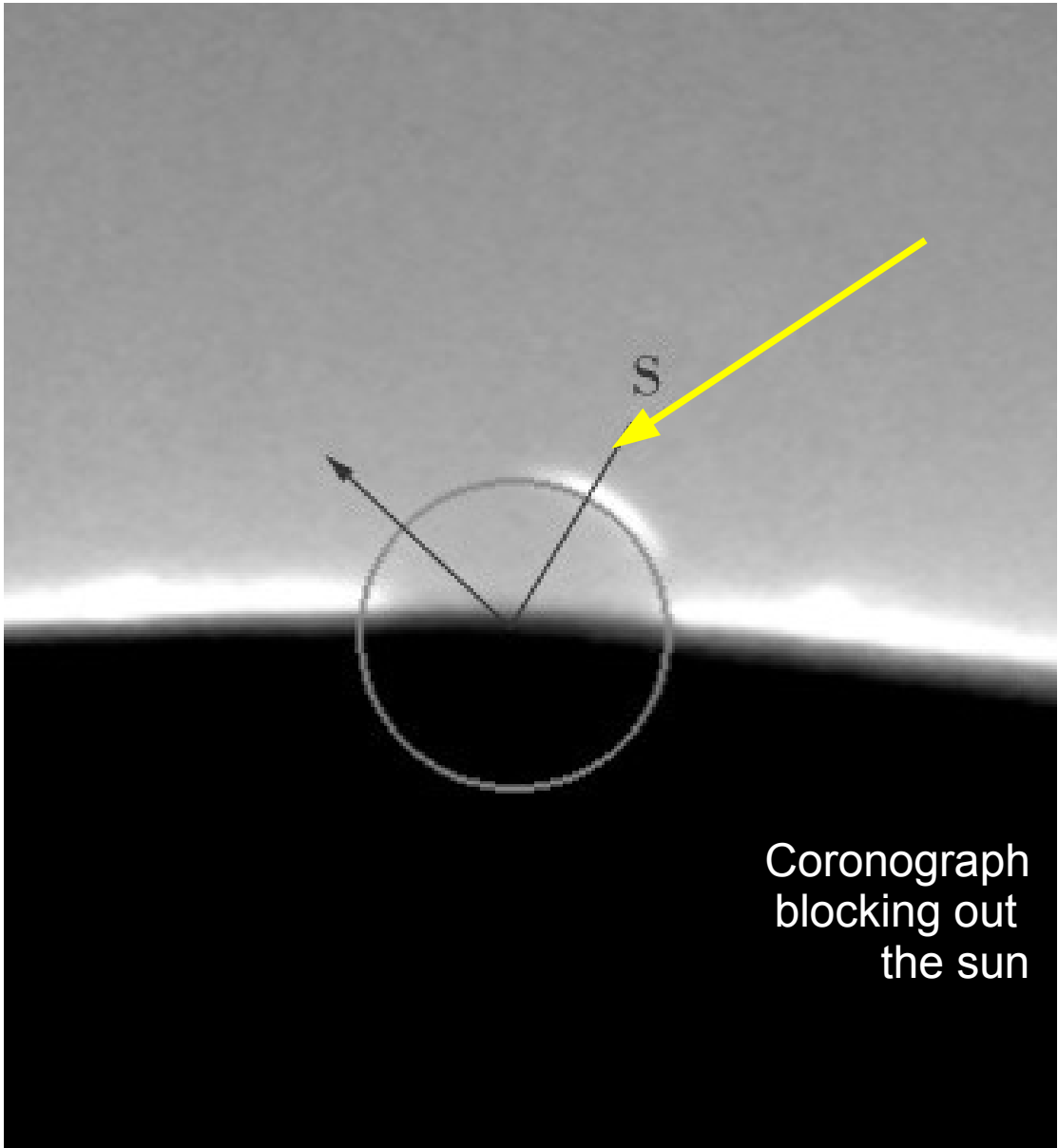
Themes of the 2000s

Simultanous observations of Venus
from the Earth and from space.

Venus as an Earth-sized planet
near the Habitable Zone
passing in front of
a Sun-like star.

Venus research: Aureole

- Thin arc of light, refracted light through Venus's atmosphere
- First observed in 1761, first photographed in 2004
- Brightness and shape depend on Venus's atmospheric properties
- Help determining whether the atmospheric phenomena detected by Venus Express (orbiting since 2006) are linked to variations in time or in latitude



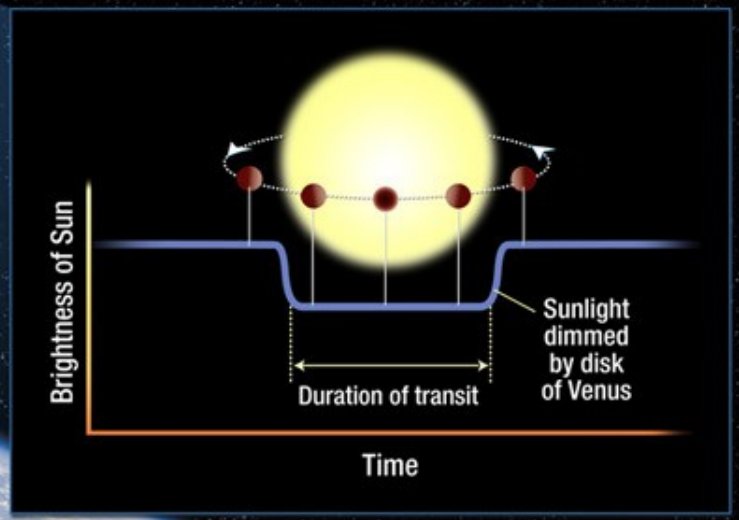
Extrasolar planet research

- Surrogate to test observing methods and strategies, validate concepts, etc.
- Detection limits of different gases in the atmosphere
- Compare the predictions of atmospheric models (based on probe data) to the real event
- If Venus were an extrasolar planet, what known-to-exist features would we miss or misinterpret based on our observations?

Tonight

- Direct and indirect spectroscopic observations of the atmosphere
- Joint Earth- and space-based observations of the atmosphere (focus on the complex middle layer)
- School class projects, smartphone apps, amateur viewing events, etc.
- Last chance to see it

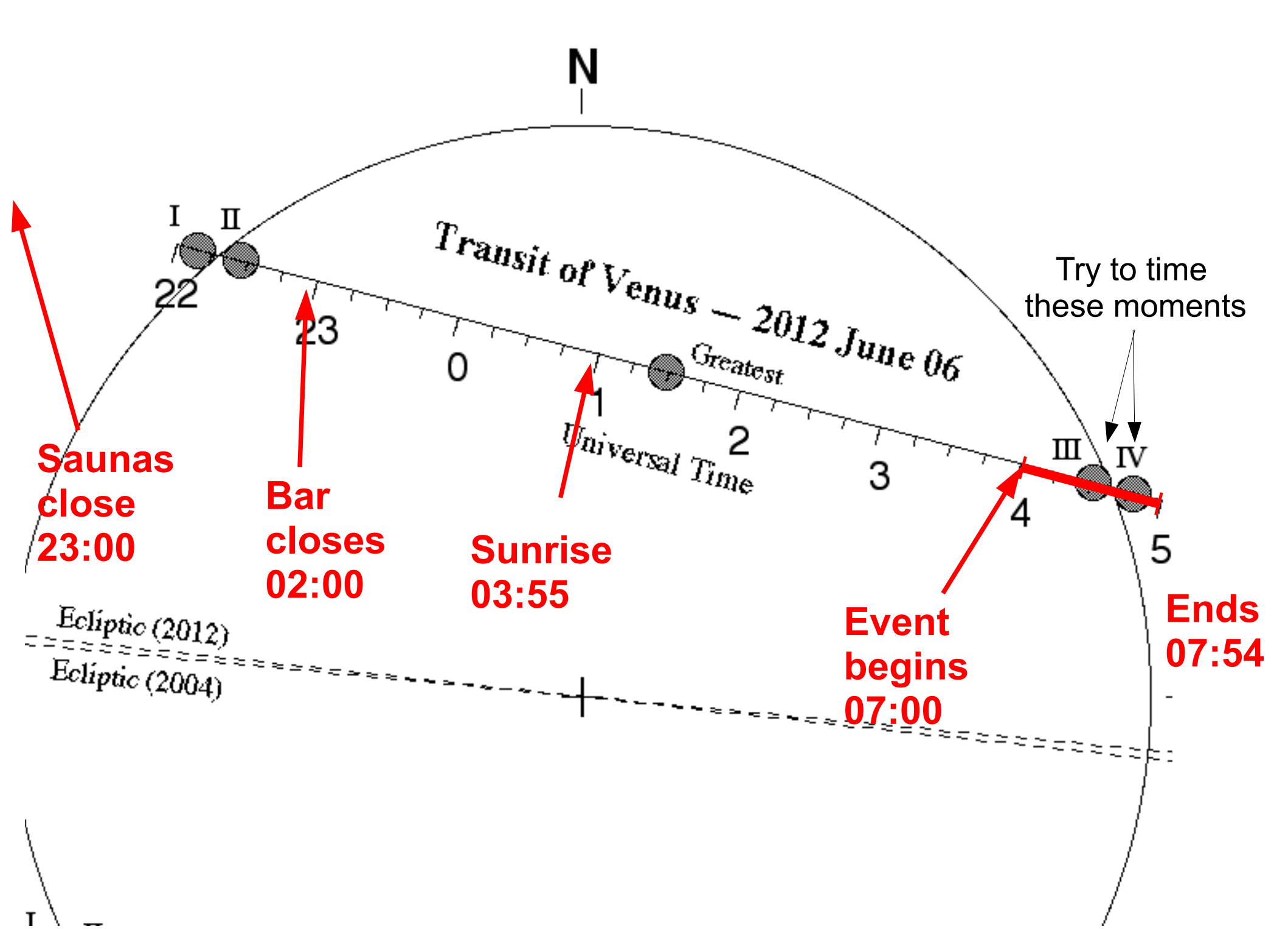
Hubble uses Moon as a mirror to observe Venus transit



Our event

- 07:00–08:00 near the saunas
- Dobson + eclipse glasses
- Trying to time the last two contact points

- Probably some media people around...


N
I
II
Transit of Venus — 2012 June 06
22
23
0
Greatest
1
Universal Time
2
3
4
III
IV
5
Try to time
these moments
Saunas
close
23:00
Bar
closes
02:00
Sunrise
03:55
Event
begins
07:00
Ends
07:54
Ecliptic (2012)
Ecliptic (2004)