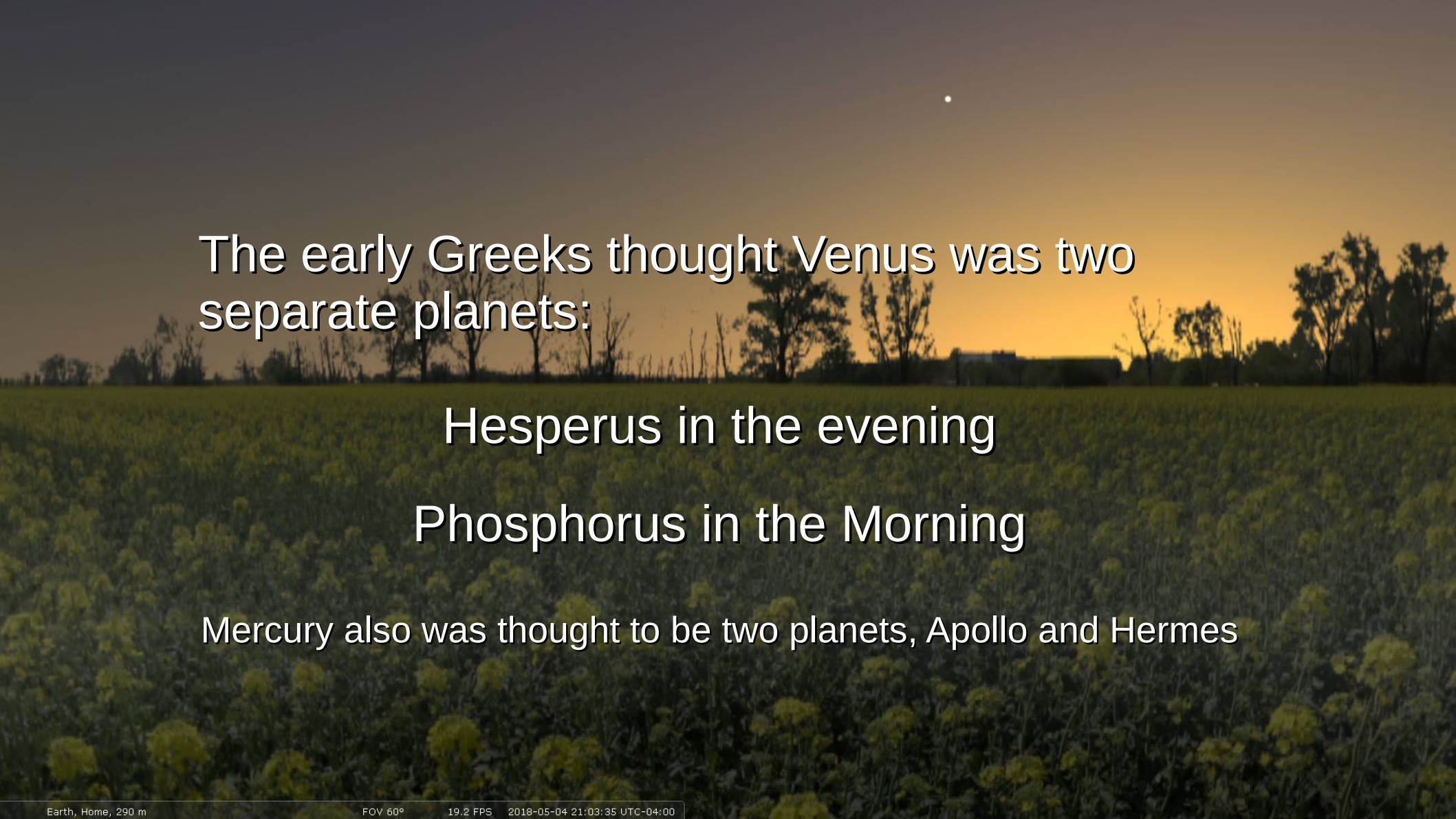
Venus, From the Mists of Time to Today

Bob Moler

Venus' Current Cycle

584 Days

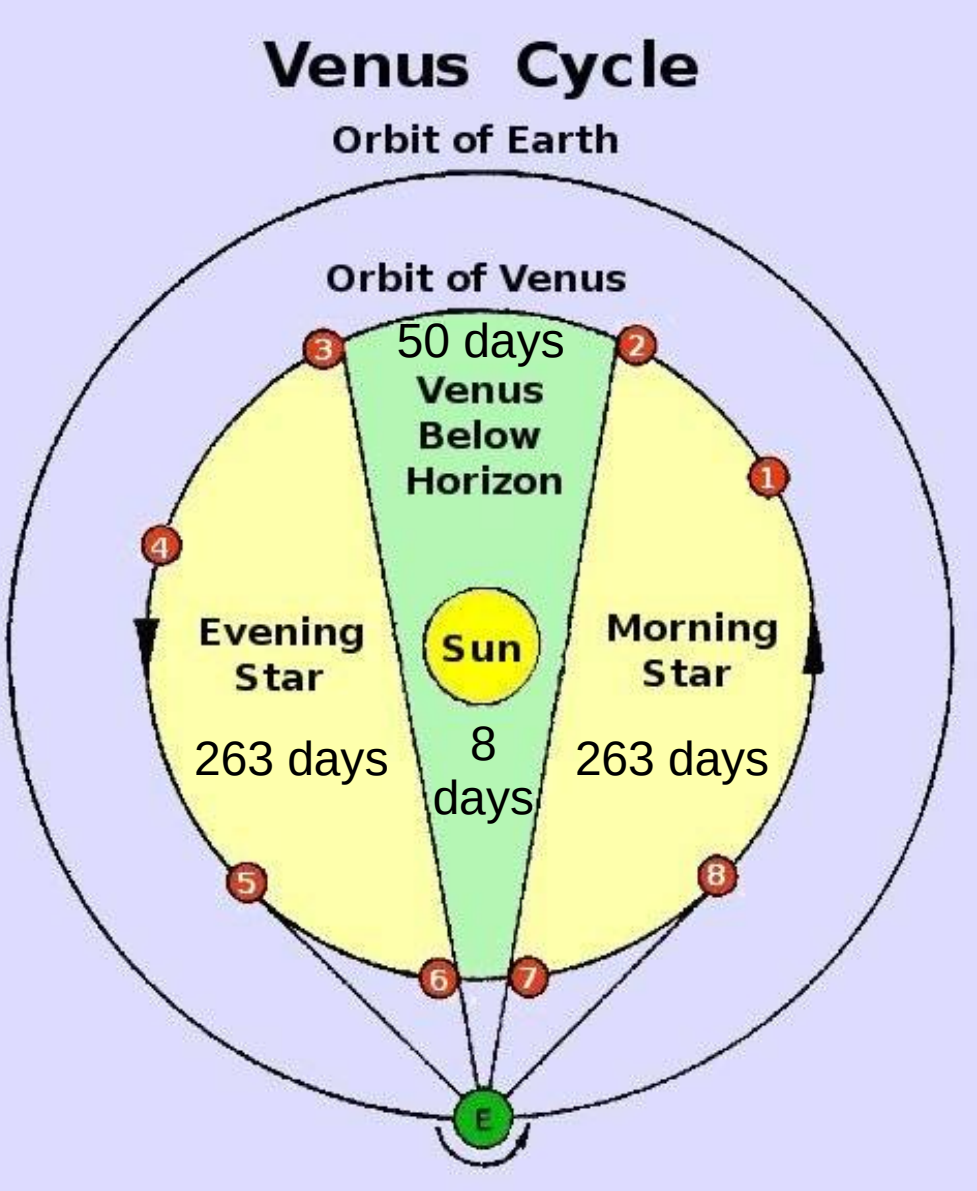
Venus passed inferior conjunction with the Sun June 3rd 2020.
It should appear in the morning twilight by June 7th 2020.
It's greatest western elongation will occur on August 12th 2020 at 45.8°.
It should disappear close to the Sun in morning twilight about March 1st 2021.
Venus will pass behind the Sun in superior conjunction on March 26th 2021.
It should become visible in evening twilight on April 20th 2021.
It's greatest eastern elongation will occur on October 29th 2021 at 47°.
It should disappear from the evening sky on January 4th 2022.
Venus will pass inferior conjunction between the Earth and Sun on January 8th 2022.


The early Greeks thought Venus was two separate planets:
Hesperus in the evening
Phosphorus in the Morning
Mercury also was thought to be two planets, Apollo and Hermes
Earth, Home, 290 m
FOV 60°
19.2 FPS
2018-05-04 21:03:35 UTC-04:00

El Caracol observation tower in Chichèn Itzá

Mayan Glyph for Venus

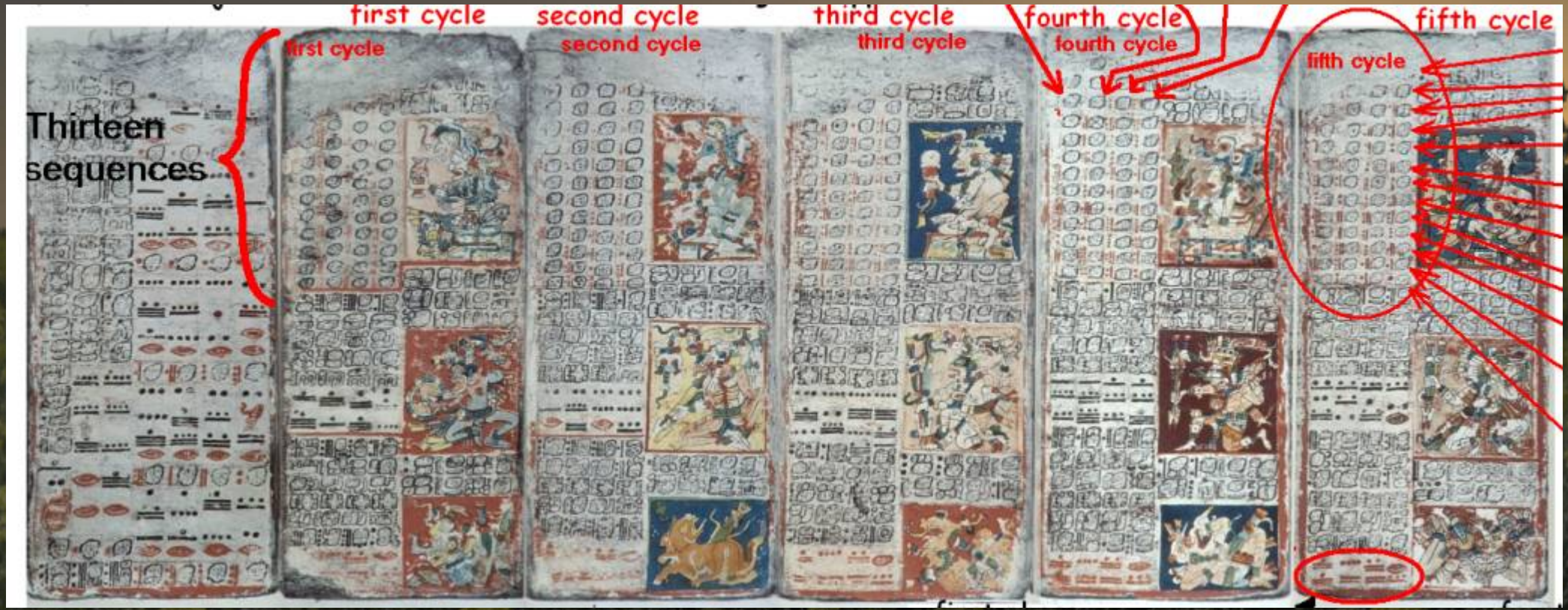
The Mayans based one of their calendars on the 584 day synodic period of Venus (Inferior conjunction to inferior conjunction)



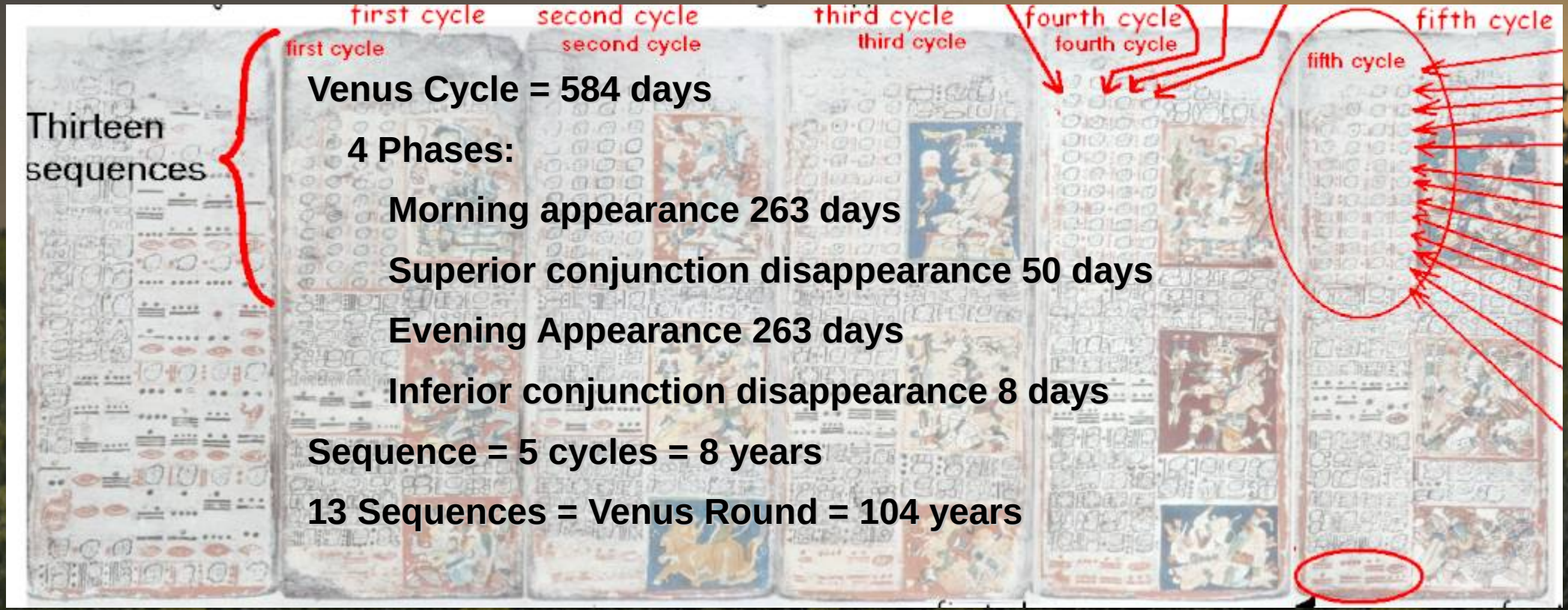
50 + 263 + 8 + 263 = 584 days in the Venus Synodic Cycle

584 X 5 = 2920 days = 7.994 years

The Venus Cycle pages of the Dresden Codex



The Venus Cycle pages of the Dresden Codex



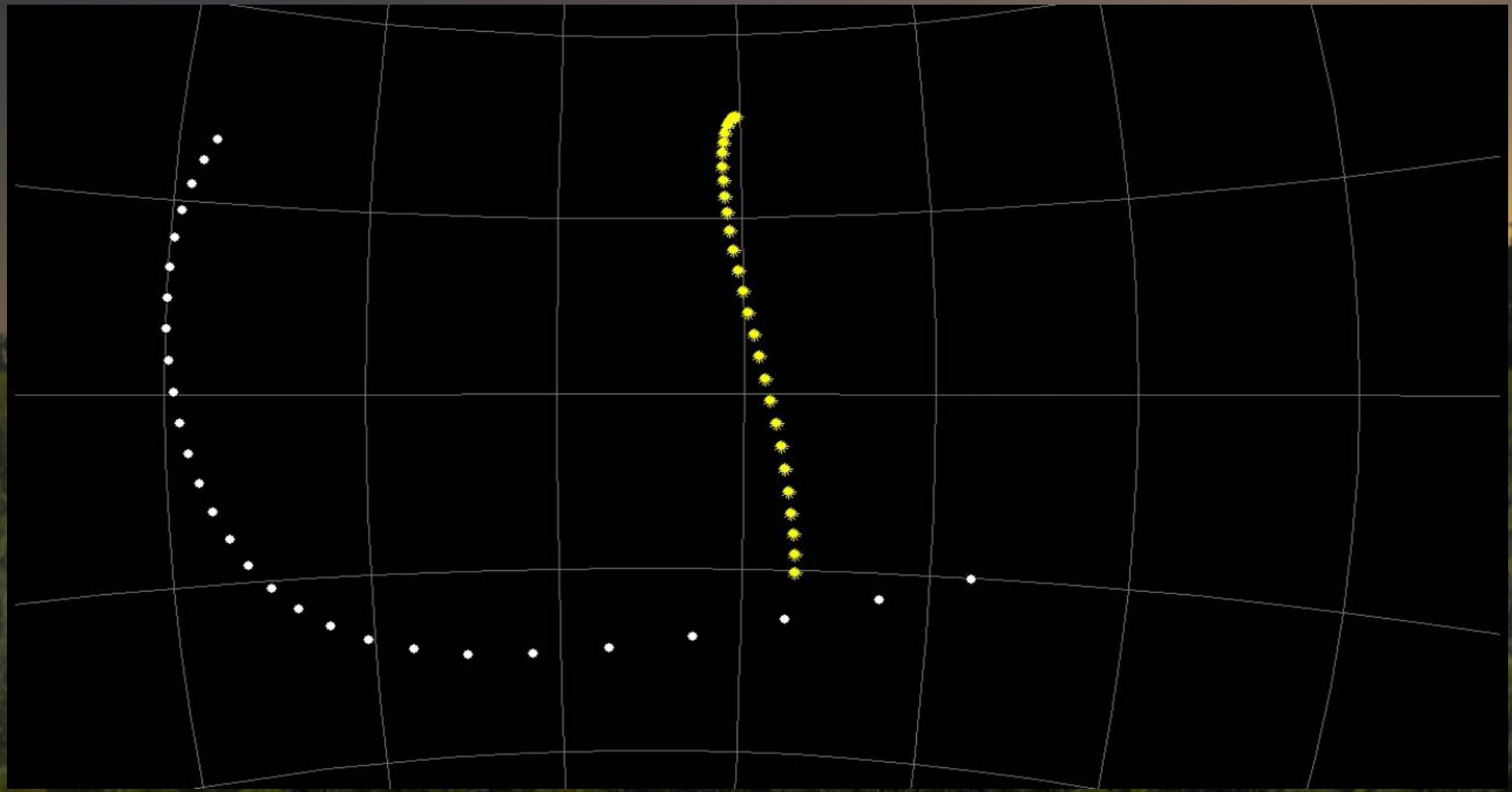
Reconstructed Dresden Codex

Lacambalam

Kulkulkan, the deity associated with Venus

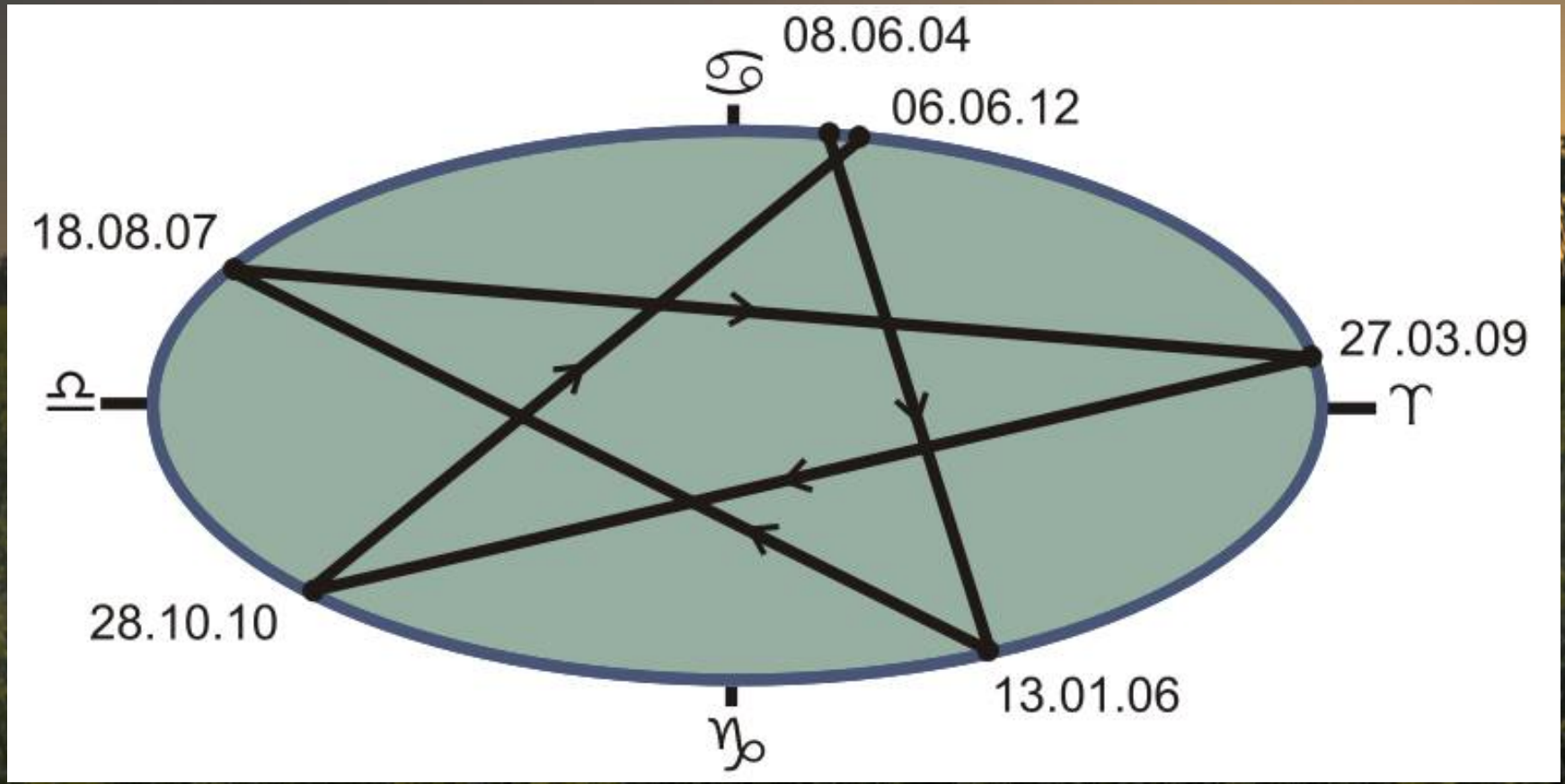
What follows is the 5 Cycle, 8 year Sequence of Venus plotted with the Sun's analemma

Looking south at local noon
Plotting the Sun and Venus every 5 days

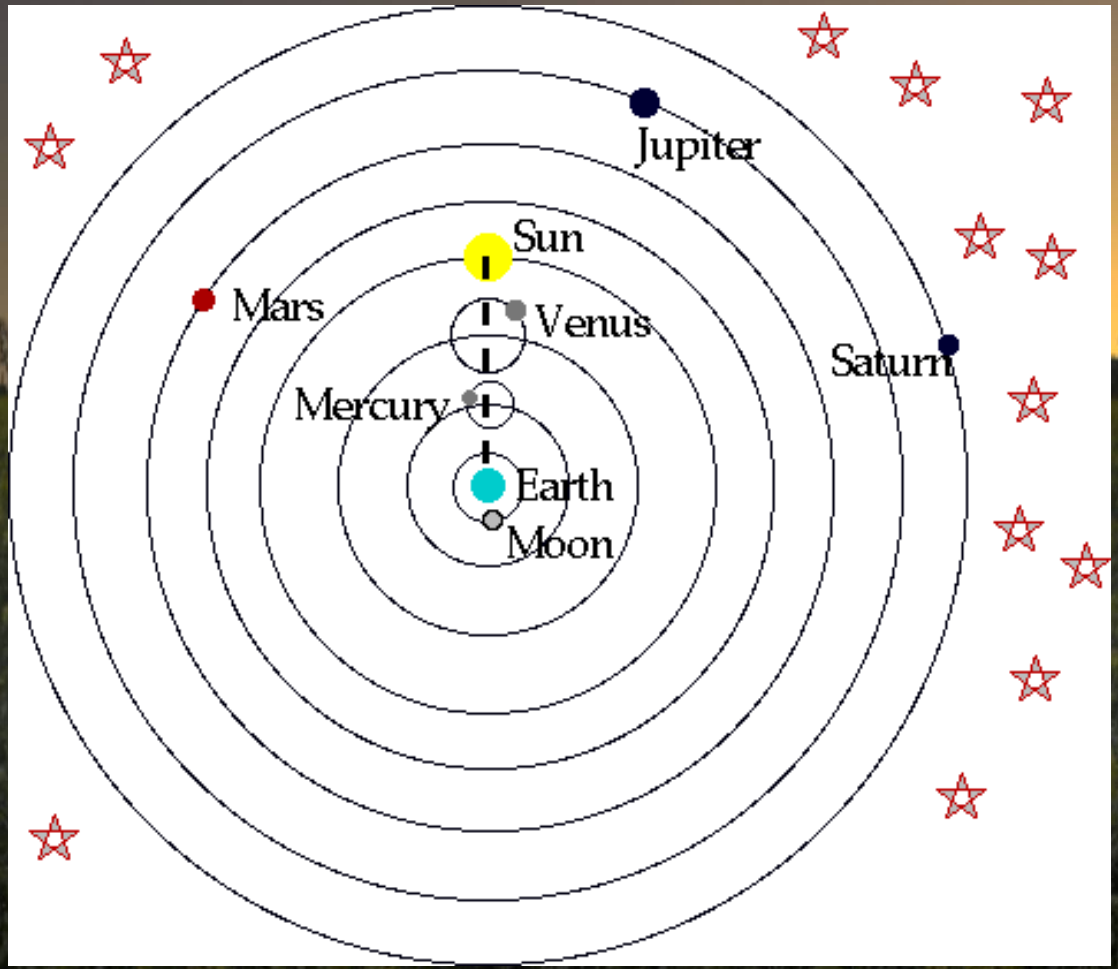


Earth, Home, 290 m FOV 60° 19.2 FPS 2018-05-04 21:03:35 UTC-04:00

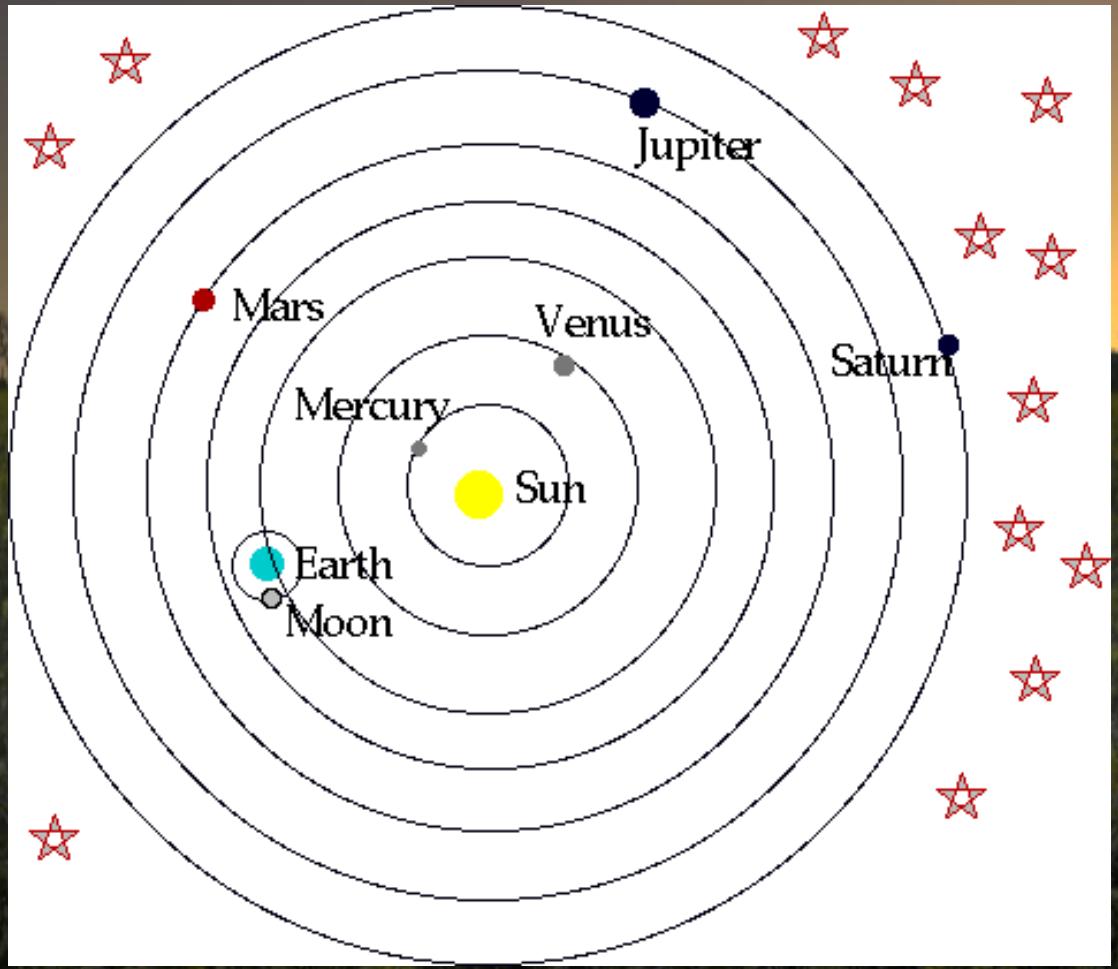
The Venus Pentagram (geocentric)



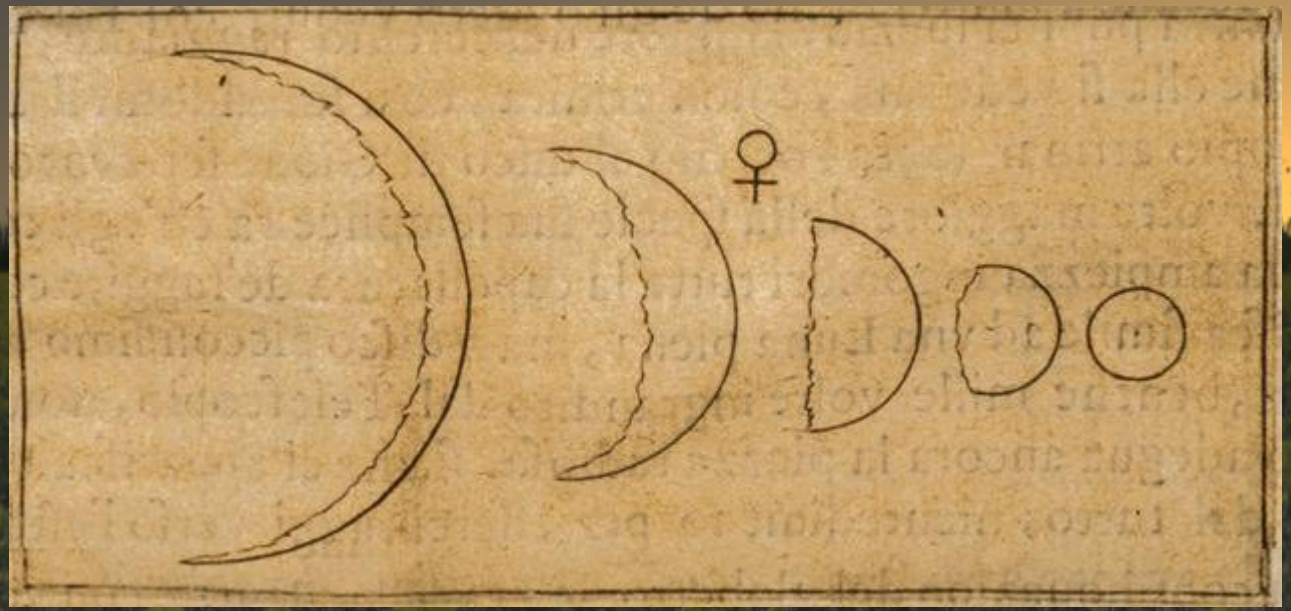
Simplified geocentric model of the solar system



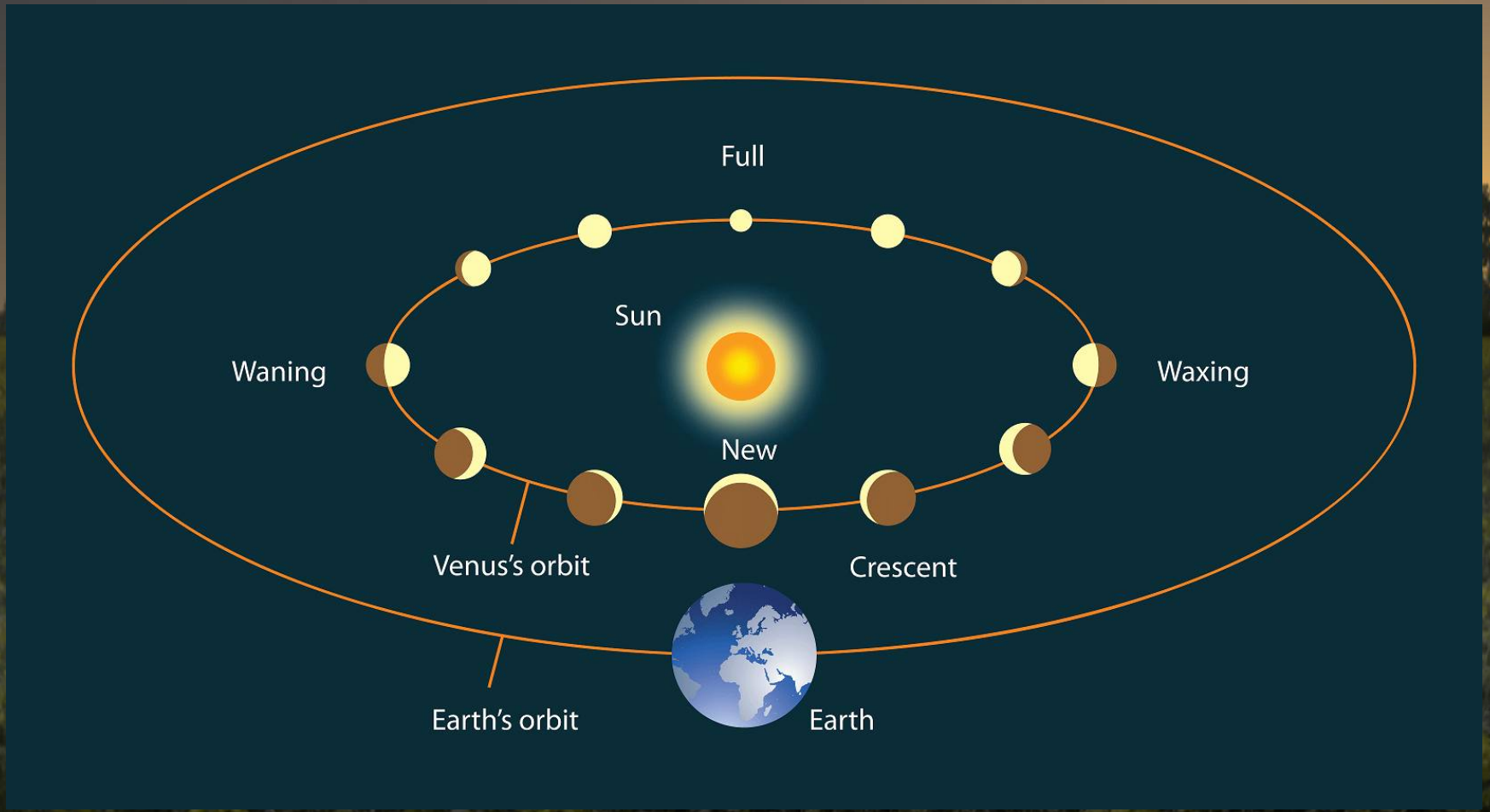
Simplified heliocentric model of the solar system



Galileo’s telescopic observations of Venus which is a proof of Copernicus’ heliocentric theory



Venus’ size and phase changes over a cycle



Venus can be used to set the scale of the Solar System

Kepler's third law of planetary motion defined the ratios of the distances of the planets from the Sun, but not their actual distances.

$$a^3 = p^2 \quad \text{or} \quad a = p^{2/3}$$

Where: a = semimajor axis and p = period in years

Planetary distances:		
	Mercury	0.4
	Venus	0.7
	Earth	1.0
	Mars	1.5
	Jupiter	5.2
	Saturn	9.6

The idea is to use transits of Venus

1631/12/7 First predicted transit by Kepler. No one saw it.

8 years

1639/12/4 First scientific observation of a transit.

121.5 8 years

1761/6/6 First attempts to measure the distance of Venus.

8 years

1769/6/3 Second attempts to measure the distance of Venus.

105.5 years

1874/12/9

8 years

1882/12/6

121.5 years

2004/6/8

8 years

2012/6/6

105.5 years

2117/12/11

8 years

2125/12/8

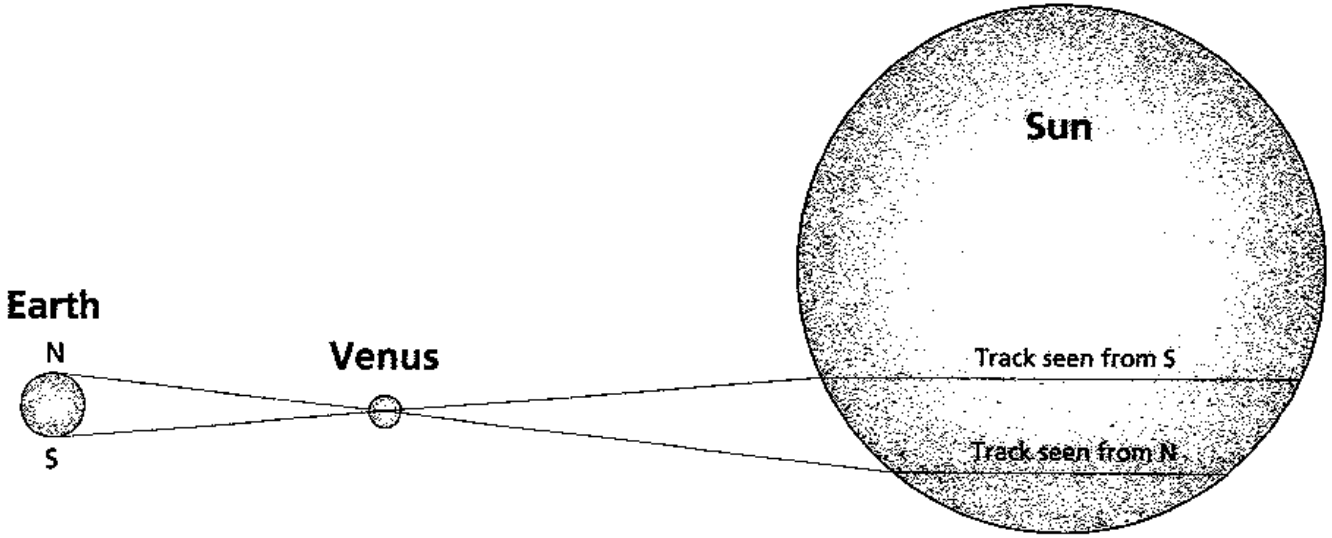
121.5 years

2247/6/11

8 years

2255/6/9

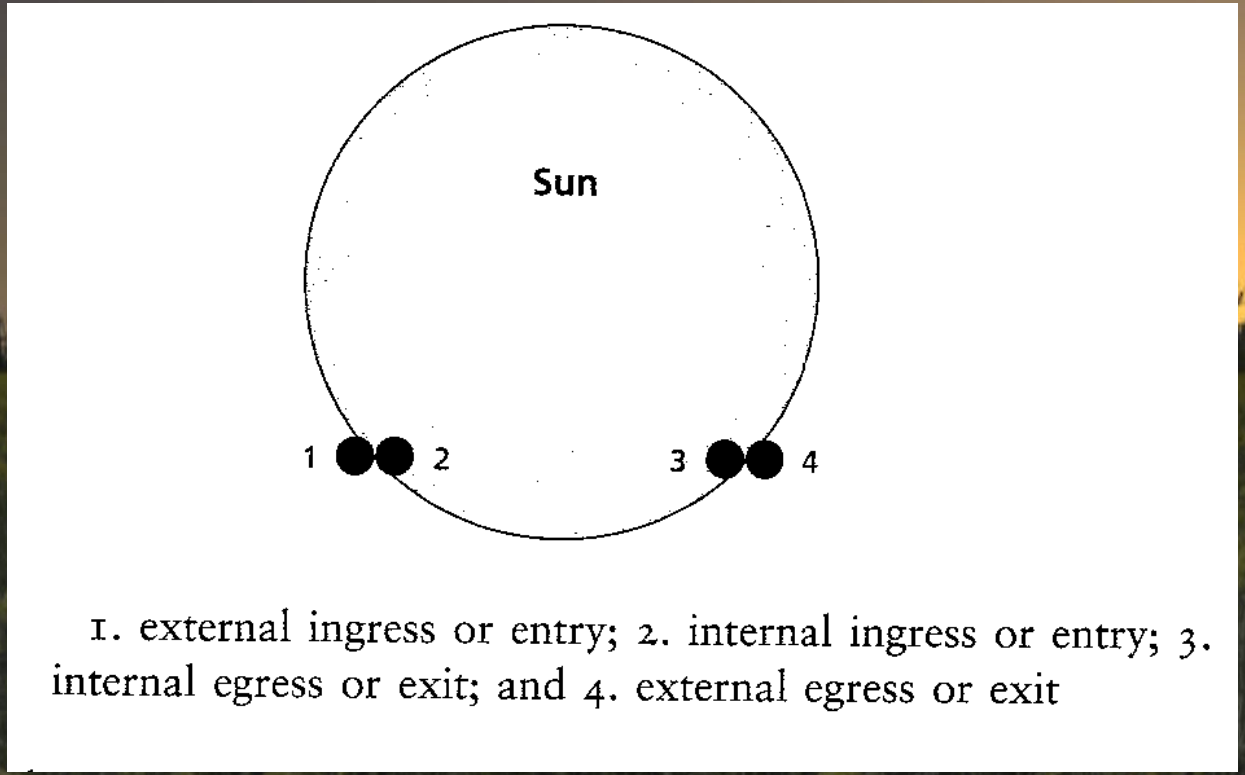
Parallax: The apparent tracks across the Sun were different lengths for northern and southern hemisphere observers



Venus's tracks as seen from observers in the northern and southern hemispheres in 1761

Chasing Venus *The Race to Measure the Heavens*, by Andrea Wulf

Parallax: The times of the ingress and egress events were affected by the observer's position on the Earth



1. external ingress or entry; 2. internal ingress or entry; 3. internal egress or exit; and 4. external egress or exit

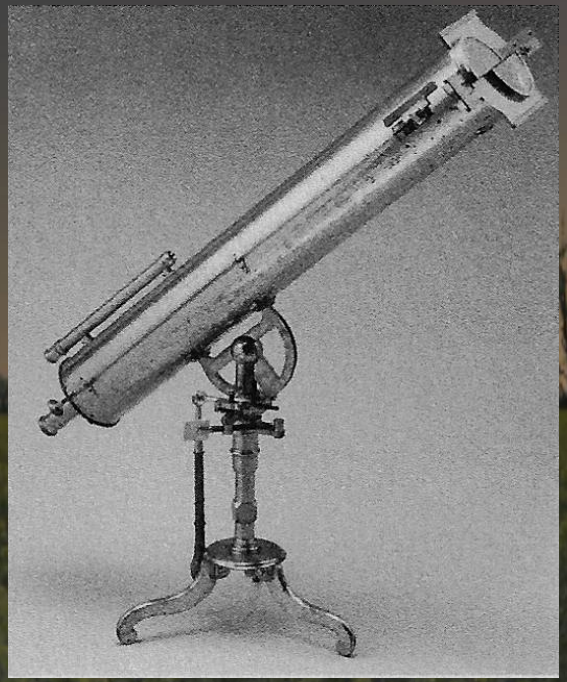
Chasing Venus The Race to Measure the Heavens, by Andrea Wulf


1761
The first attempts to measure the distance of the Sun
Conclusion:
The Sun was between 77,100,000 and 98,700,000 away
Timings were bedeviled by the ‘Black Drop Effect”
Earth, Home, 290 m
FOV 60°
19.2 FPS
2018-05-04 21:03:35 UTC-04:00

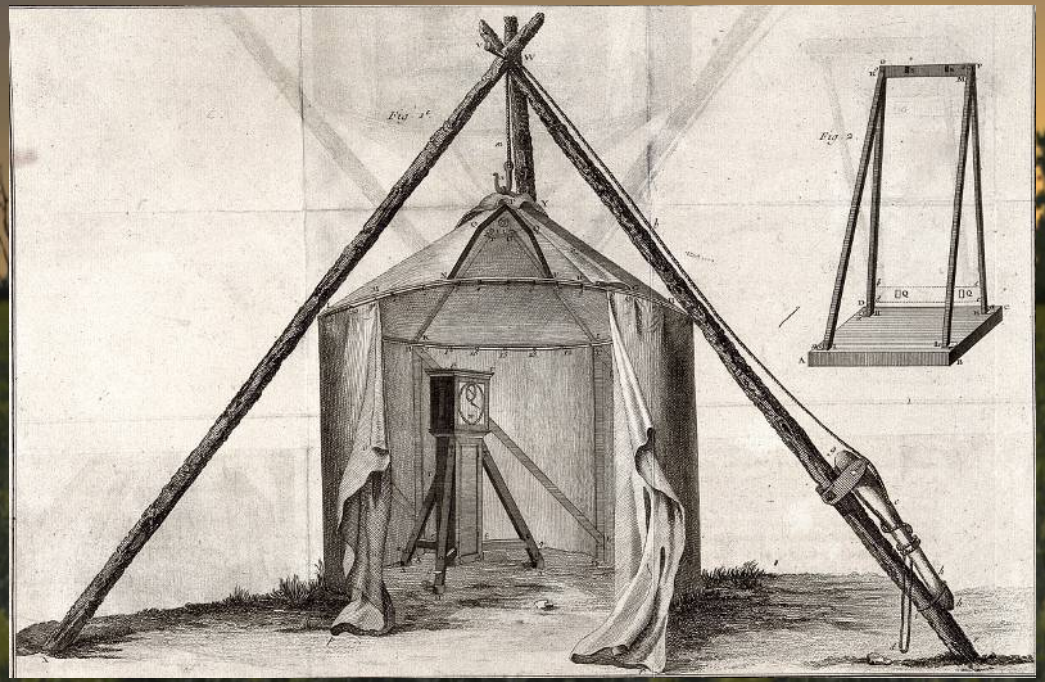

1769
International cooperation to observe the transit from
Many points across the Earth
Earth, Home, 290 m
FOV 60°
19.2 FPS
2018-05-04 21:03:35 UTC-04:00

Captain Cook’s arrival in Tahiti April 13, 1769

Instruments for observing the 1769 Transit of Venus

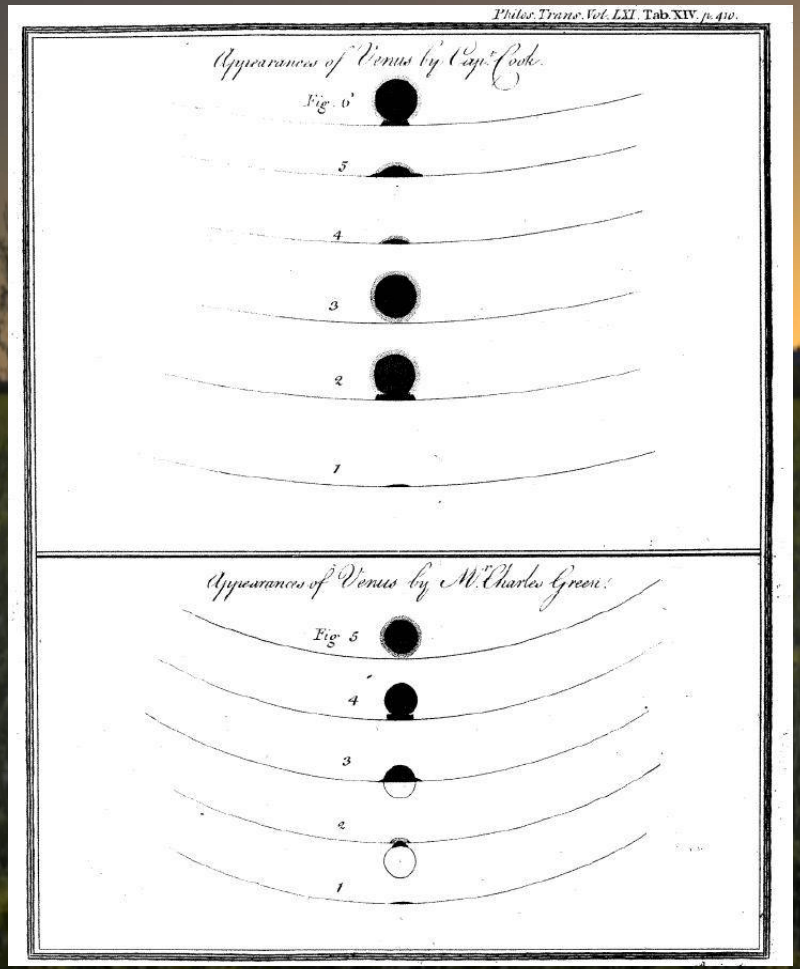


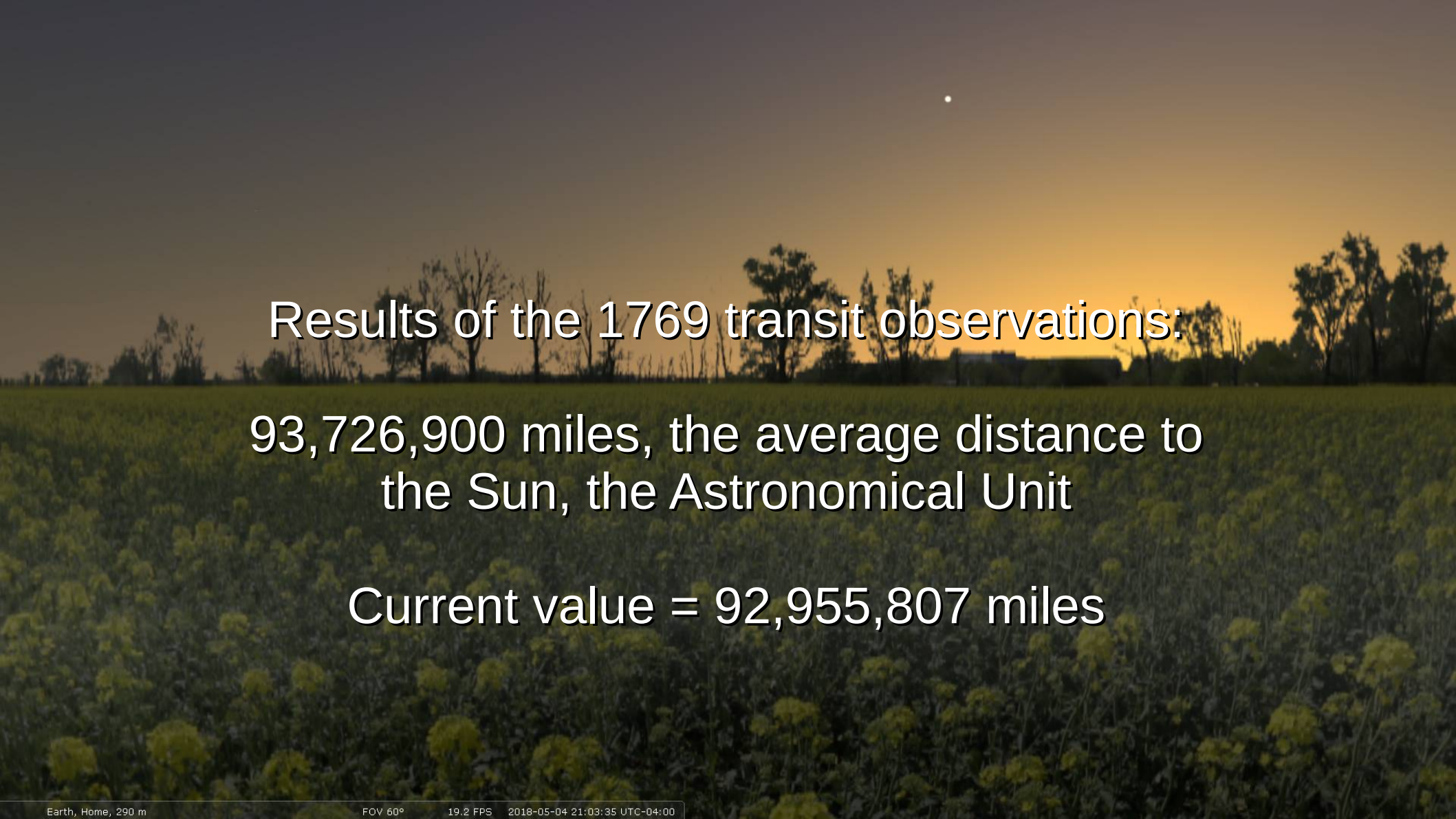
A telescope made by John Short. One of many ordered for the transit of 1769.



Made by John Sheldon for the Royal Society, pendulum clocks were placed in tents like this for transit expeditions.

The Black Drop Effect as recorded by Captain Cook and Charles Green on Tahiti




Results of the 1769 transit observations:
93,726,900 miles, the average distance to the Sun, the Astronomical Unit
Current value = 92,955,807 miles
Earth, Home, 290 m
FOV 60°
19.2 FPS
2018-05-04 21:03:35 UTC-04:00

Transits of Venus

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105.5 years

2117/12/11

8 years

2125/12/8

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2247/6/11

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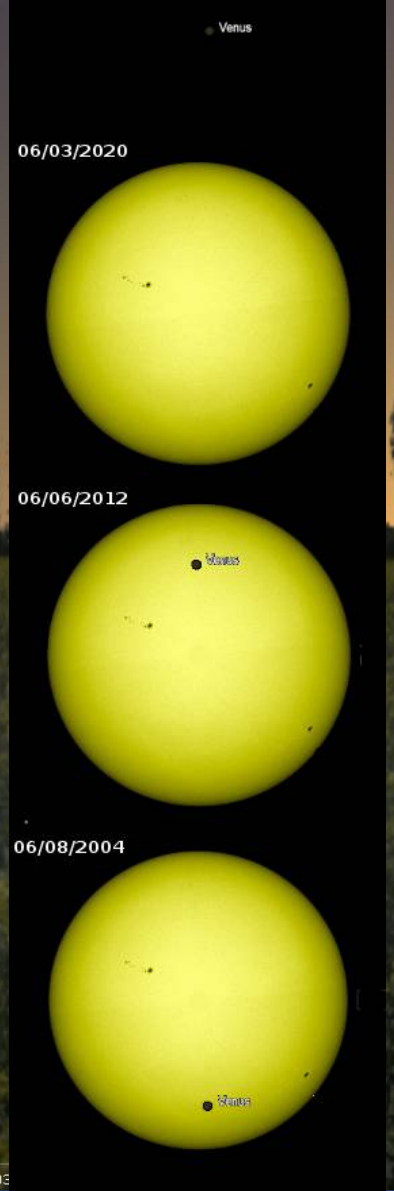
2255/6/9

Recent June inferior conjunctions

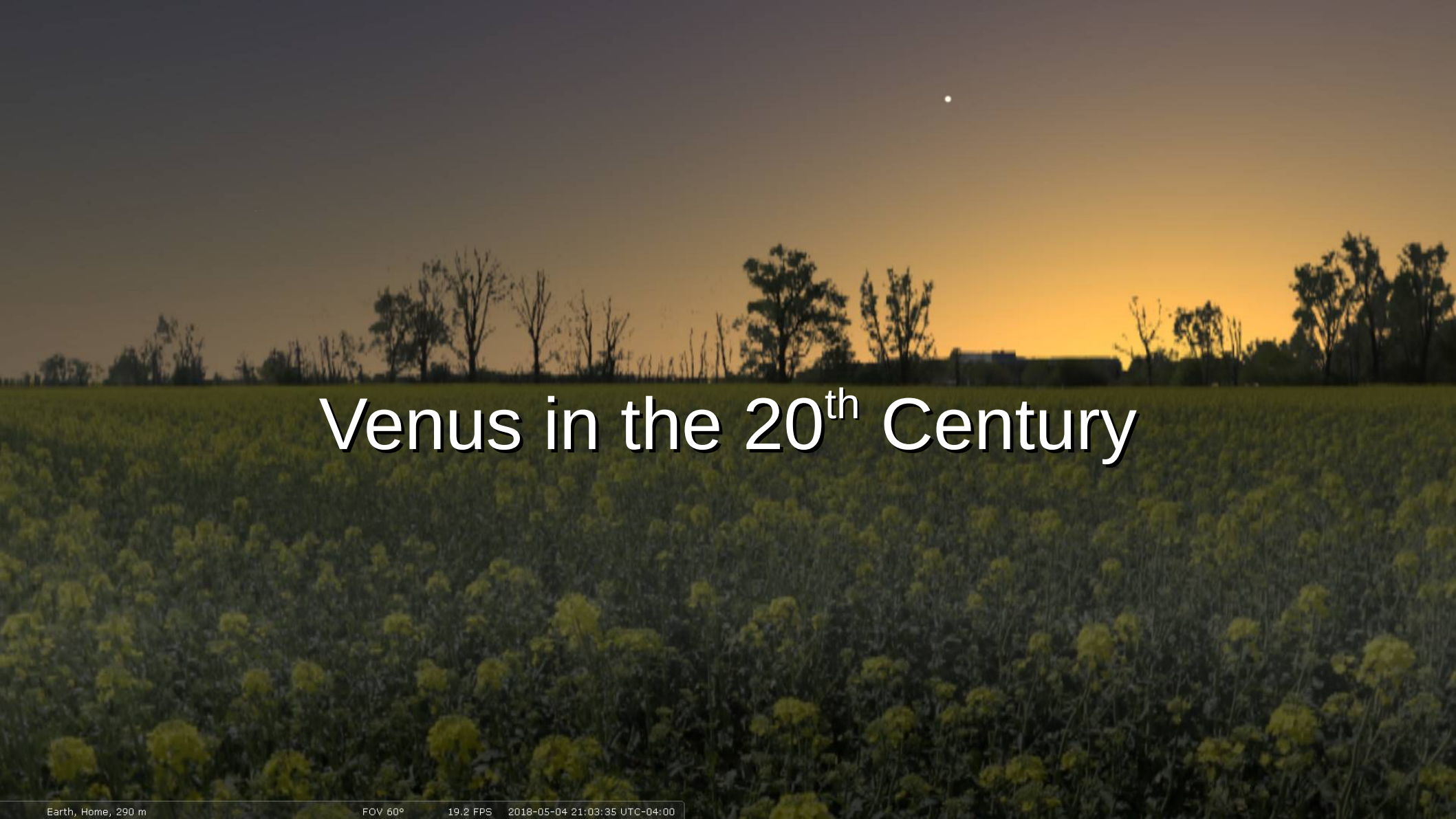
Two hits and a miss



The vertical distance between two consecutive transits is about 64% of the Sun's diameter.

In December of 3089 there will be a close to central transit. There will not be a transit 8 years later. The previous December transit of 2854 will have Venus just skirting the southern limb of the Sun.

From *Astronomical Tables of the Sun, Moon and Planets* *Third Edition* by Jean Meeus

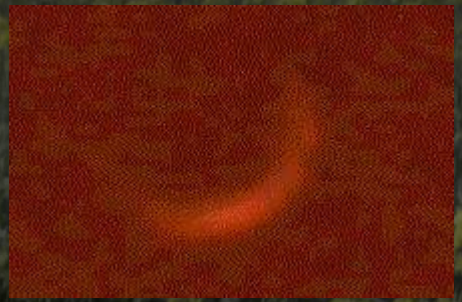

Venus in the 20th Century
Earth, Home, 290 m
FOV 60°
19.2 FPS
2018-05-04 21:03:35 UTC-04:00

Venus as it appears visually in a telescope

My photographs in the spring of 1969 as Venus approached inferior conjunction.

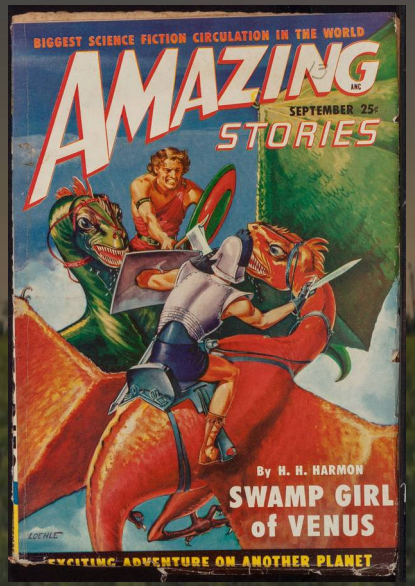
Venus, famously, can be spotted in the daytime by sharp-eyed observers.

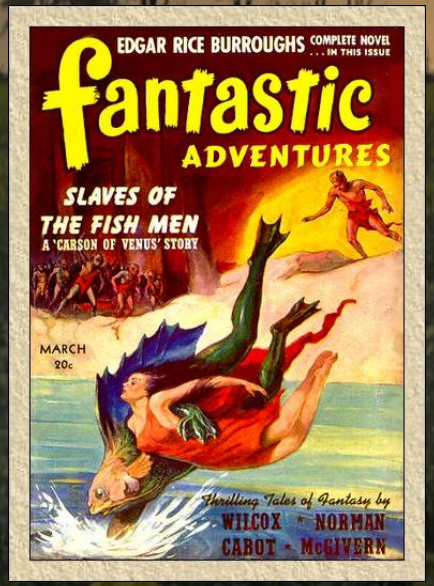
Venus, only 4 days before inferior conjunction

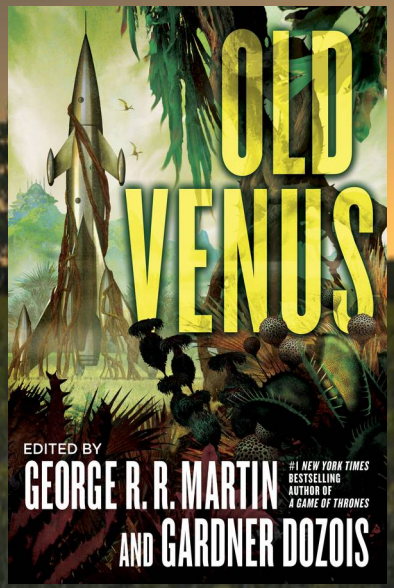


No features are discernible visually in the Venusian clouds, which reflect 77% of the Sun’s light.

Pre 1960's science fiction explores the question: "What's beneath those clouds?"







The 1960's: The veil begins to fall

NASA's Mariner 2 passed Venus on December 14, 1962 at a distance of 22,000 miles.

Observed the planet in infrared to determine the temperature of the clouds,and microwaves to measure the temperature of the surface.

The atmosphere turned out to be hot! 500º C or 900º F. The surface nearly the same, with little day-night variation.

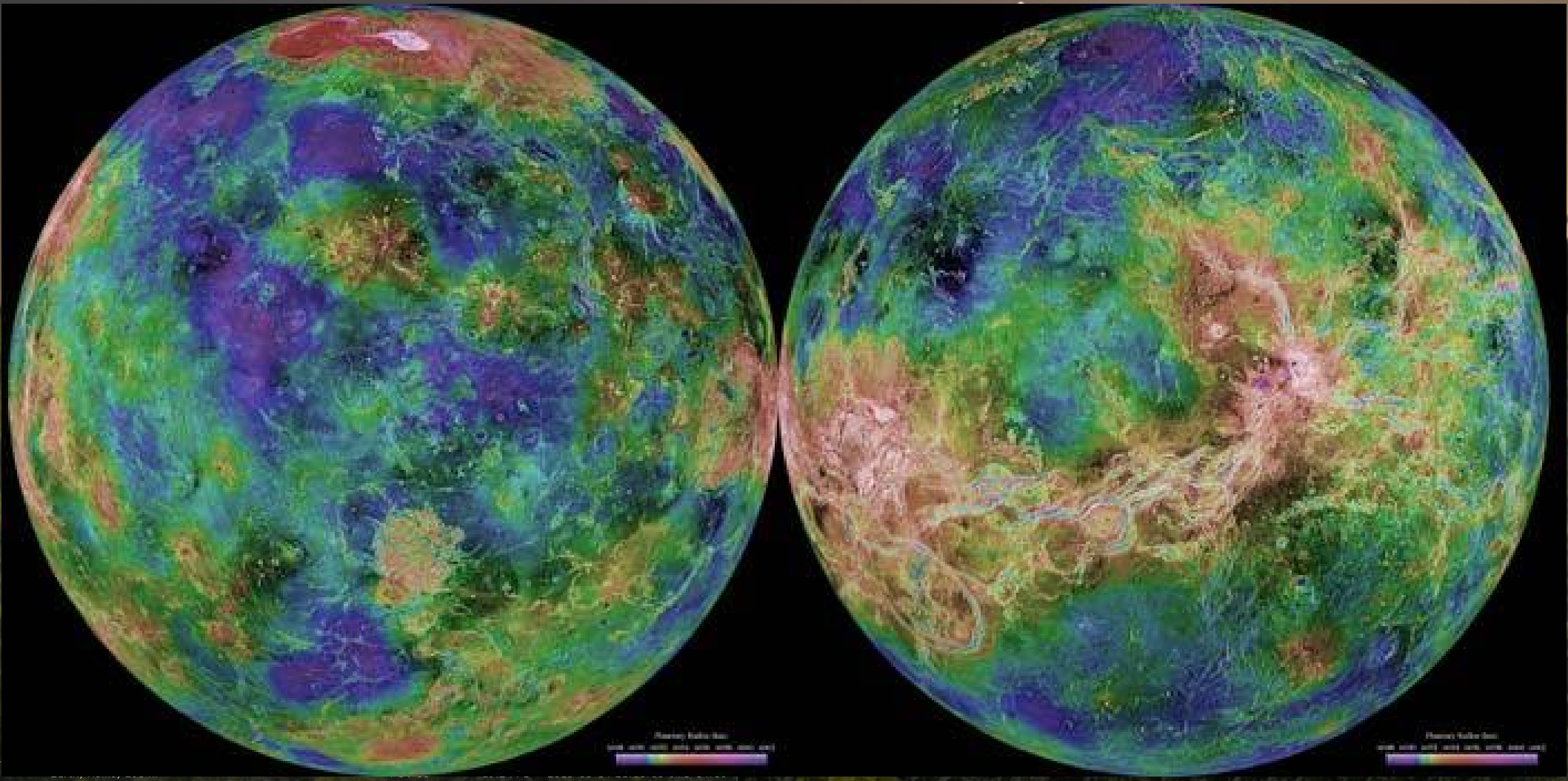
Probing Venus from the Earth via radar

In 1963 the Goldstone and Arecibo Radio observatories announced that radar studies of Venus revealed that Venus rotates slowly in retrograde in 243.025 days.

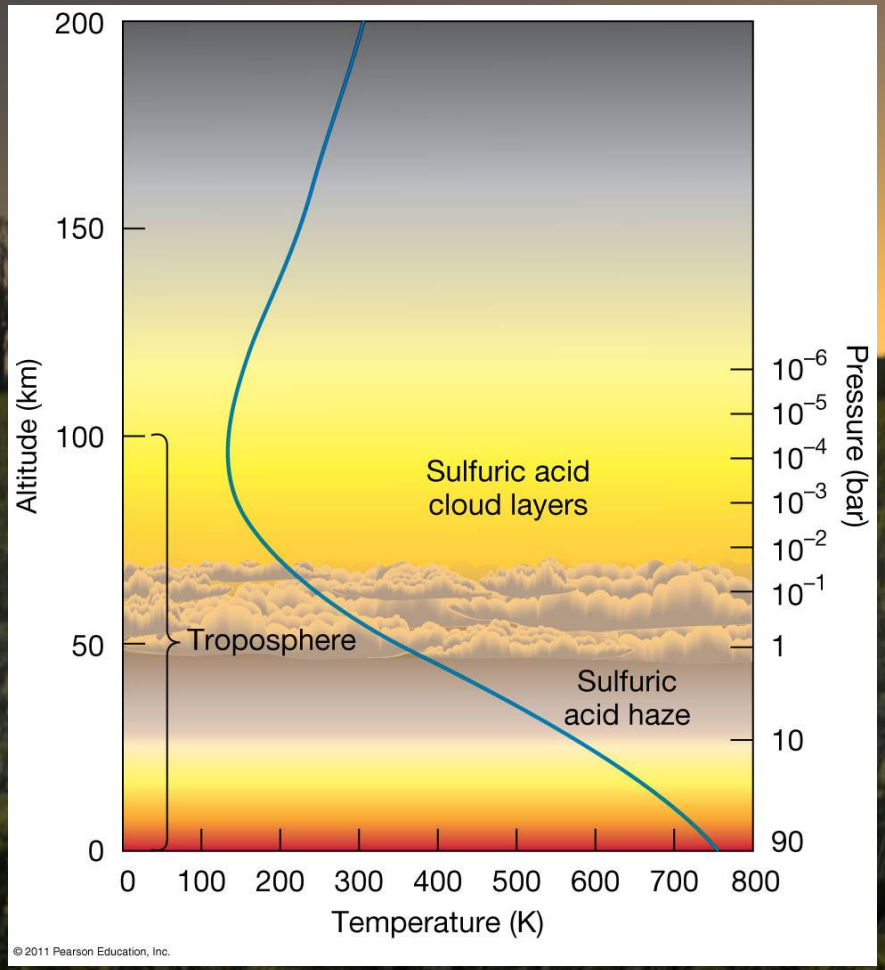
Venus' sidereal day is longer than its year of 224.701 days.

Venus' rotation rate and direction is such that the same side of Venus is facing the Earth every Inferior conjunction.

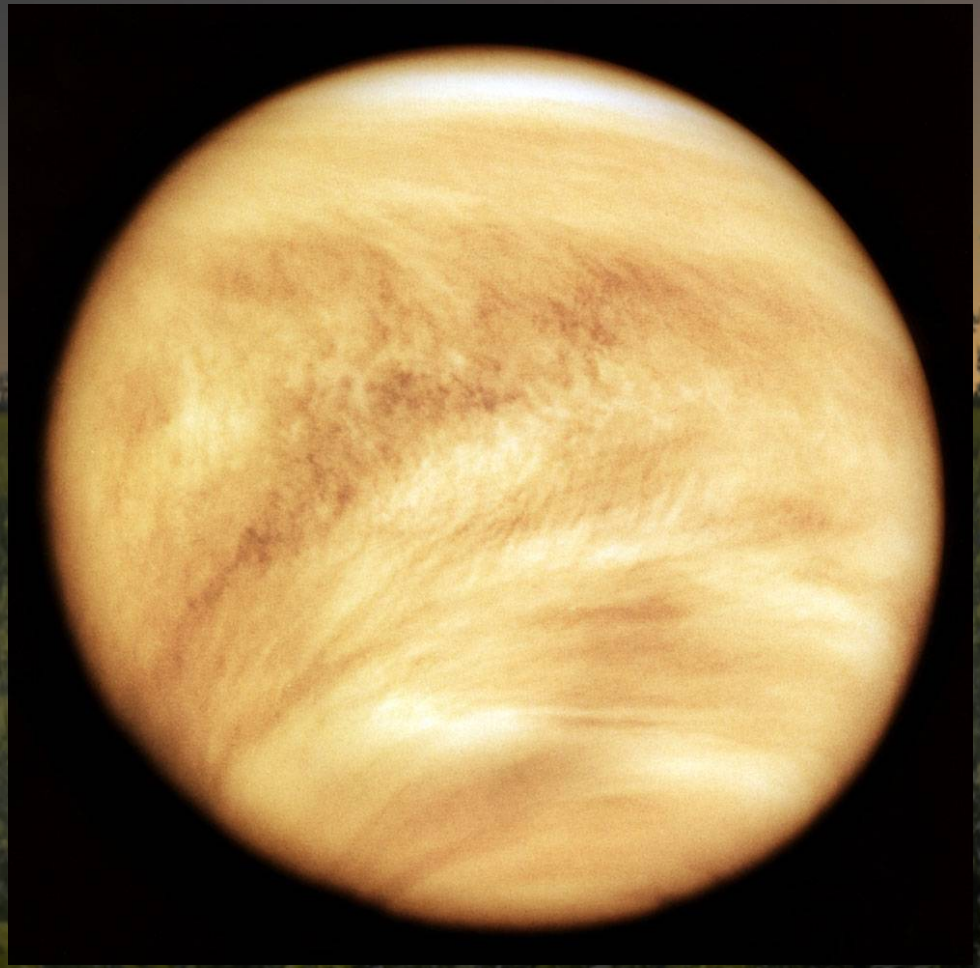
Venus as radar mapped by the Magellan Spacecraft (1990 - 1994)



Venus' atmospheric profile



Venus’ cloud detail shows up in UV and IR



At the equator wind speeds at the cloud tops reach 200-223 mph, 55 times the Venusian rotation rate.

The winds are retrograde, in the direction of the planet’s rotation.

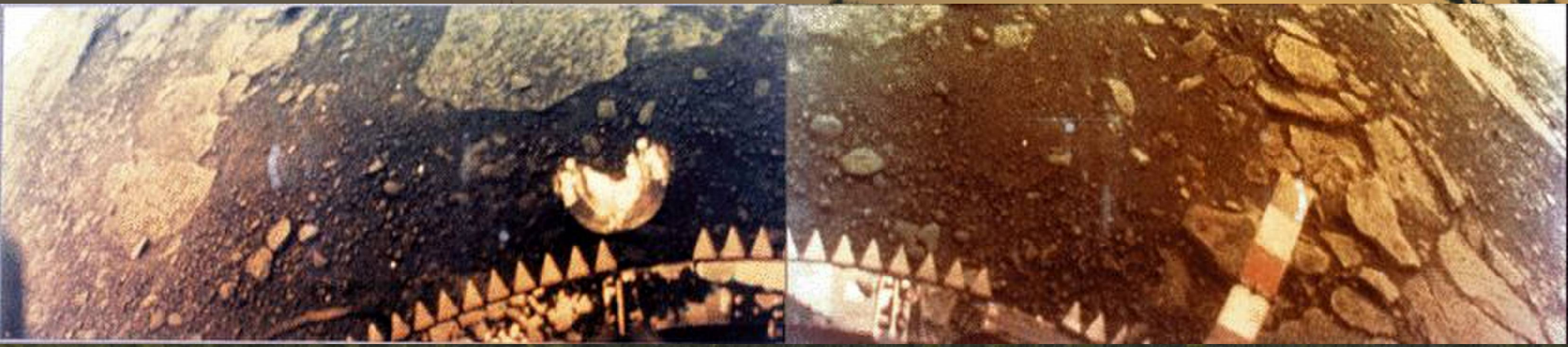
Wind speeds diminish with increased latitude.

Wind speeds lower down can be twice a fast.

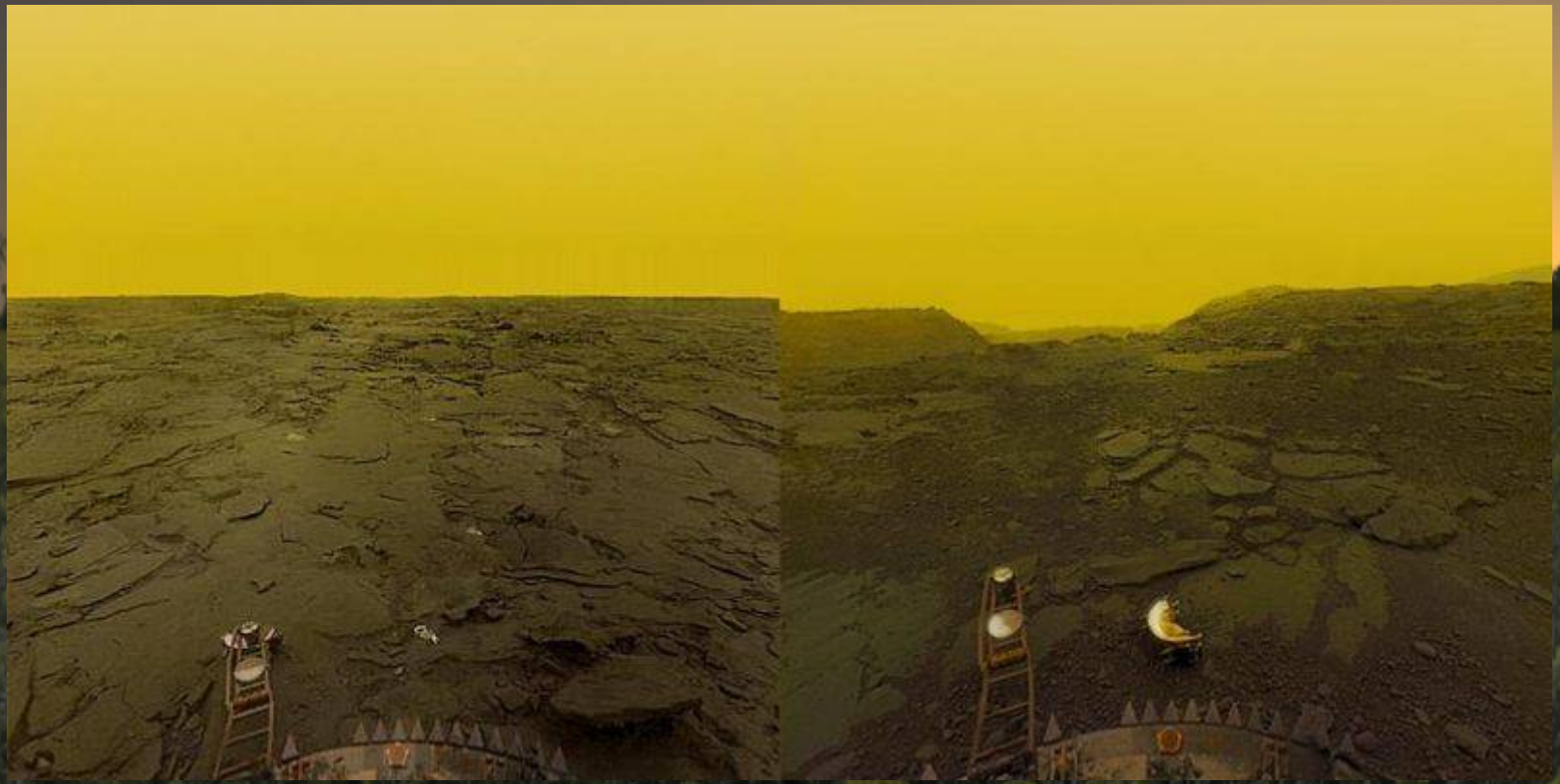
The Soviet Union sent 14 spacecraft to land on Venus. 5 succeeded

This is the Venera 13 lander. It landed on Venus on March 1, 1982. The identical Venera 14 landed 4 days later.

First color images of the surface of Venus sent by Venera 13



Composite and reworking of Venera 13 images



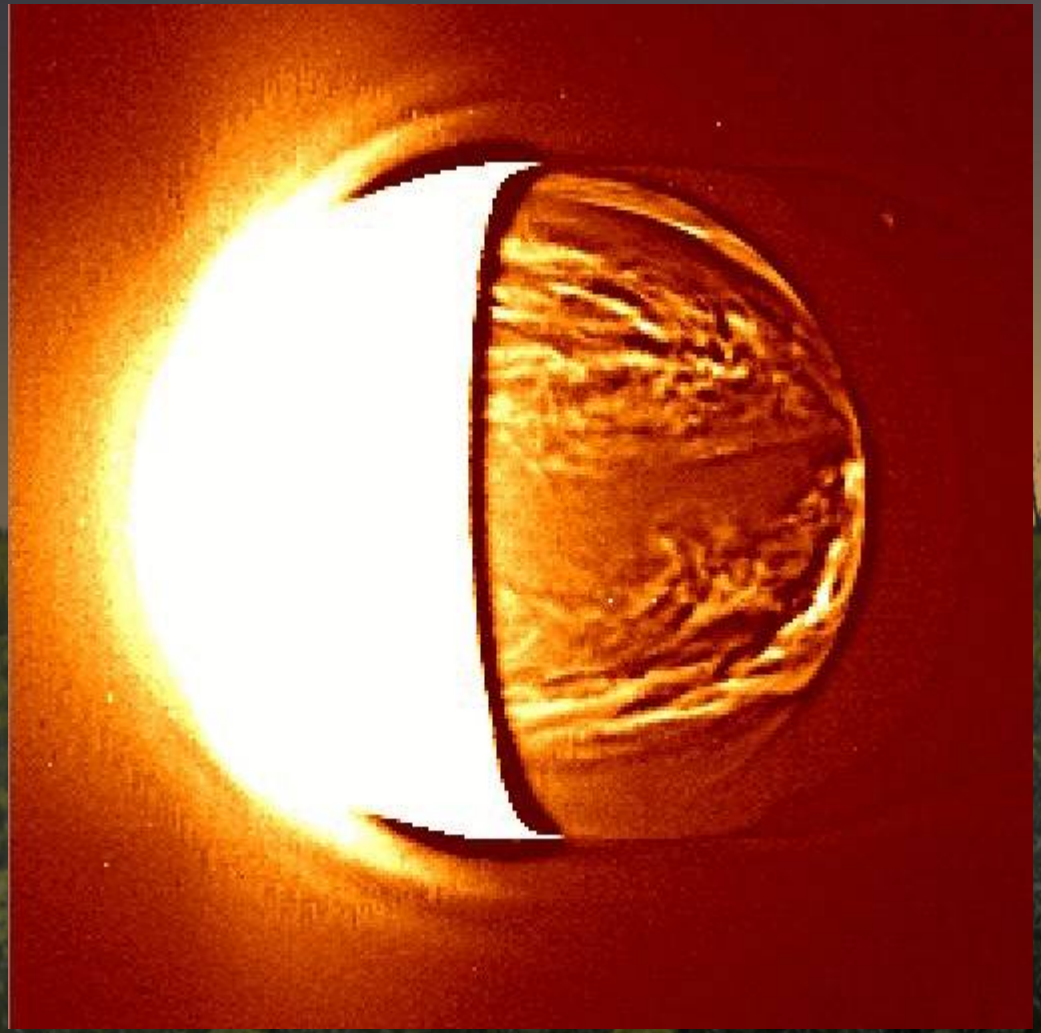
Surface temperature: 470°C (878°F)

A replica of a Vega balloon at the Udvar-Hazy Center

In 1985 Russia sent two probes, Vega 1 and Vega 2 to intercept Halley's Comet.

On the way they dropped off two landers with balloons.

Though one lander failed, both balloons successfully traveled about 7,000 miles at 33 miles altitude, at half the sea level pressure on Earth at an Arizona like temperature of around 100º F.



Animation of the clouds on Venus' night side

Akatsuki

AKA Planet-C renamed Akatsuki failed to be inserted in orbit of Venus due to a rocket motor failure. However mission controllers would try again with the attitude thrusters 5 years later when the spacecraft again passed the planet. They were successful December 7, 2015.

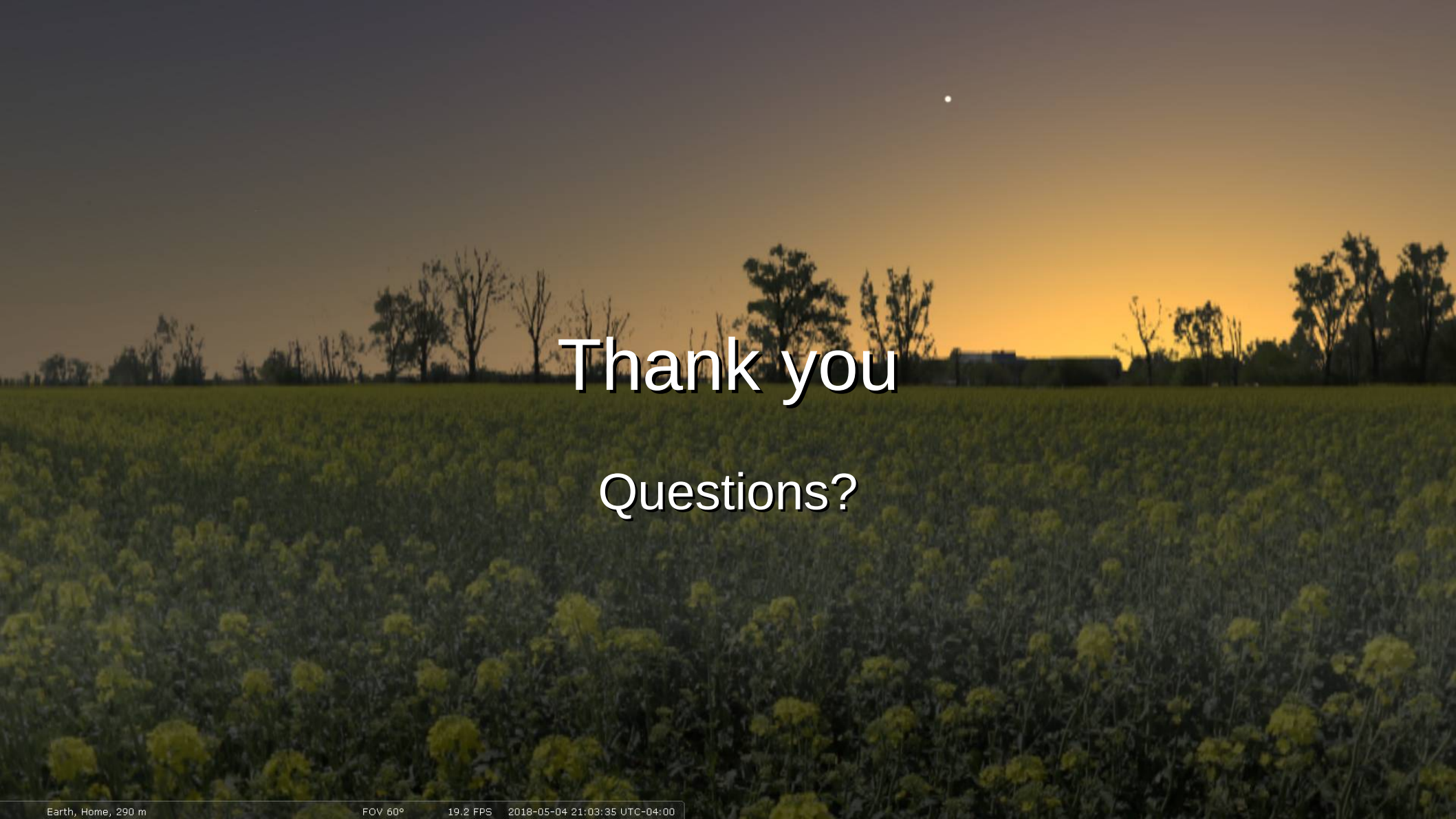
Future strategies for exploring Venus

Balloons

Solar powered drones

Manned orbiters

Landers with electronics able to withstand the heat


Thank you
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