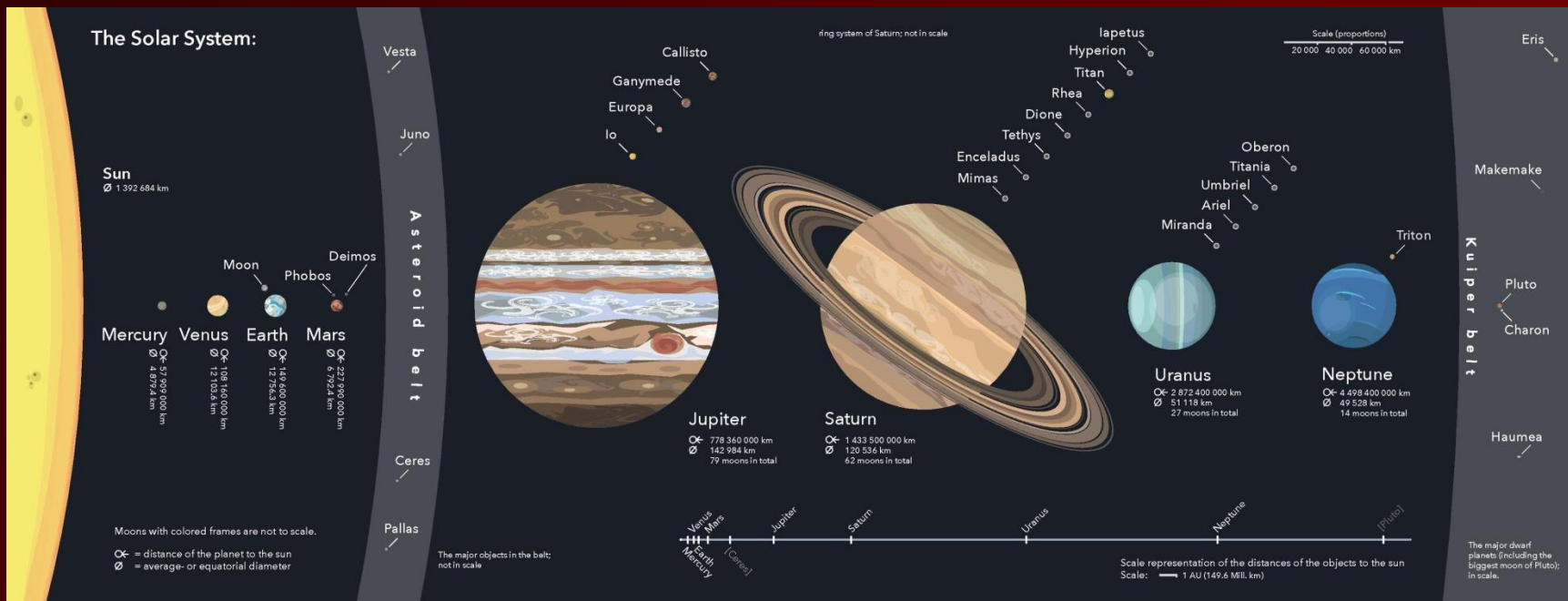




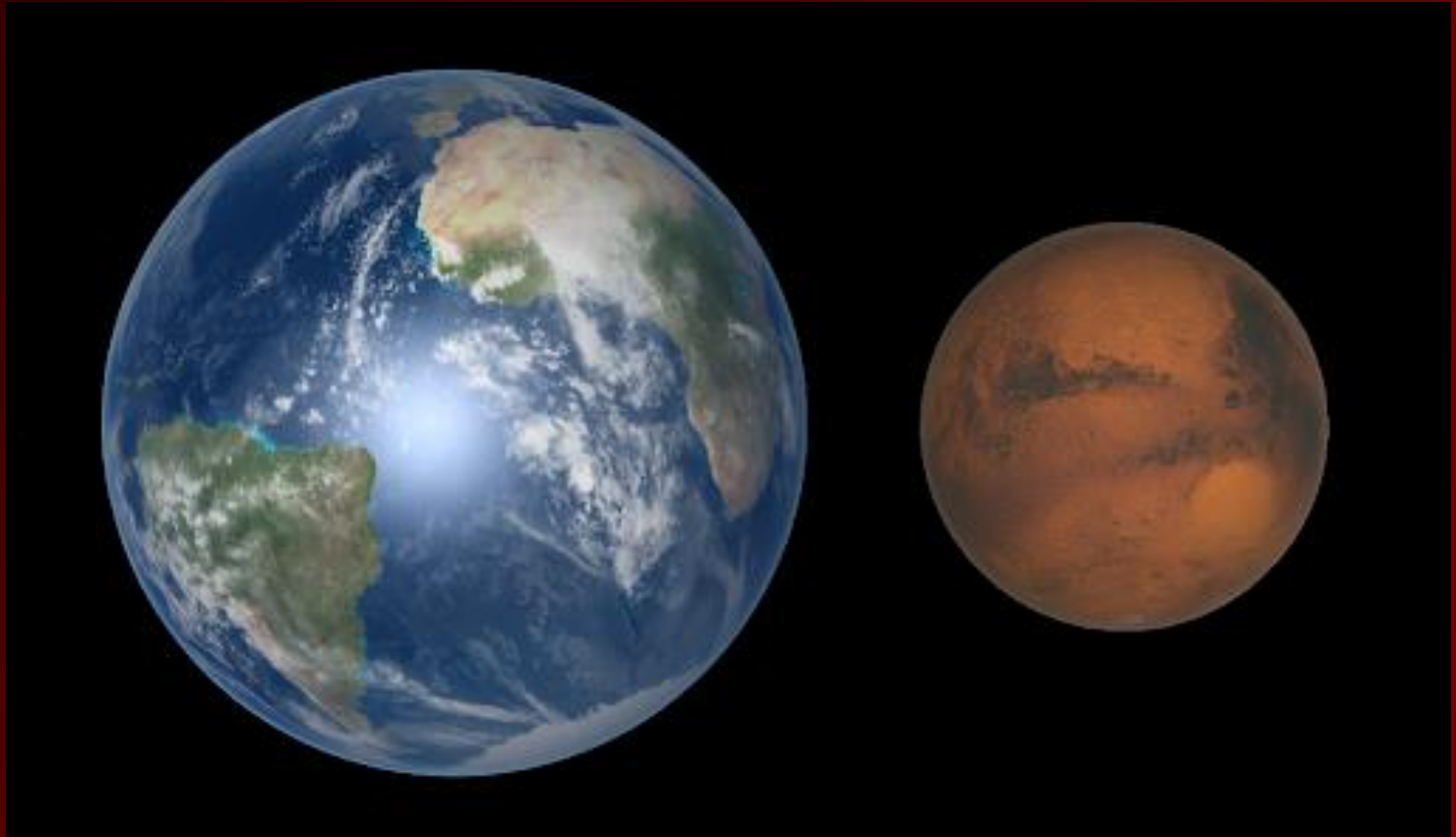
Mars



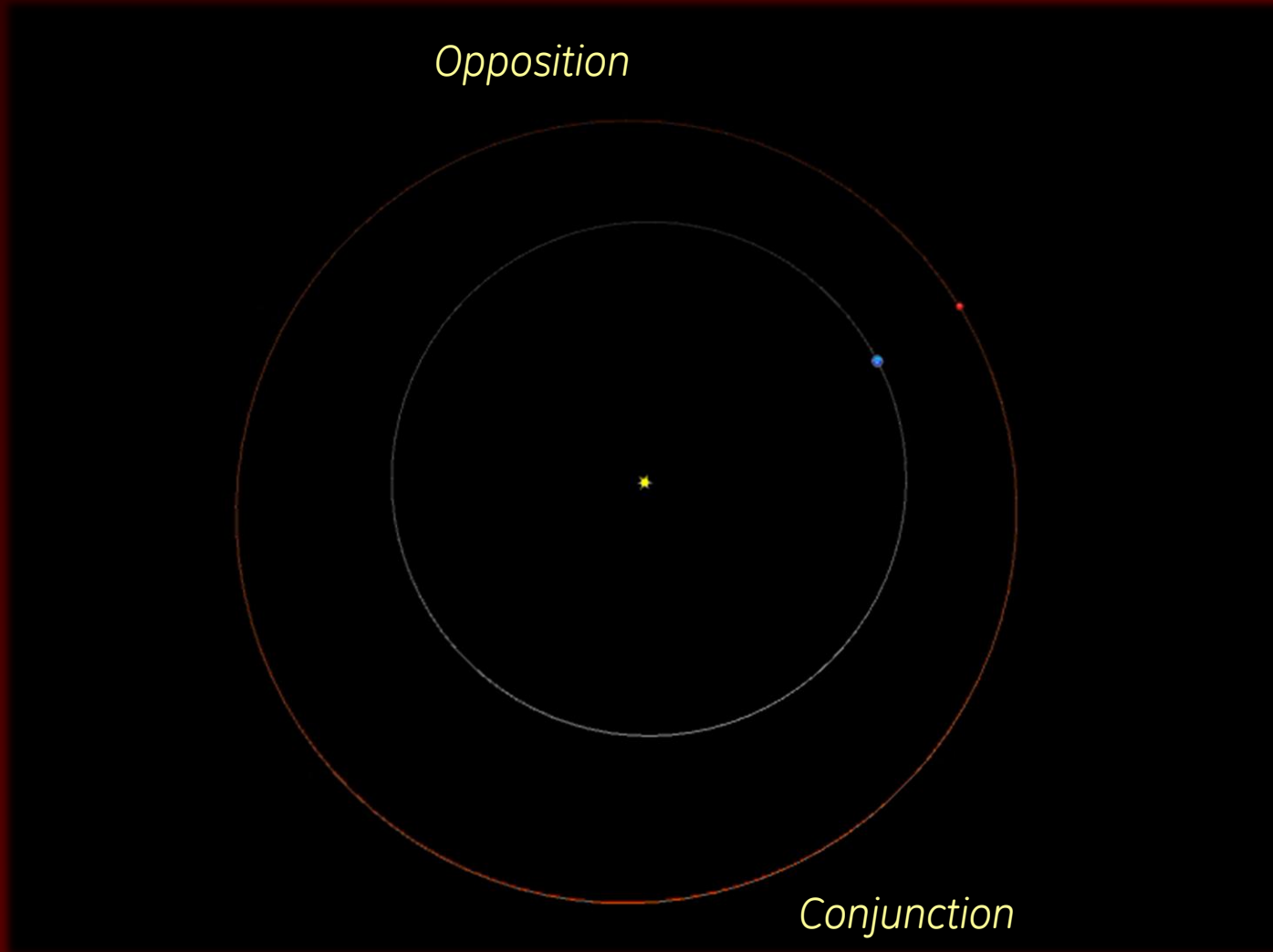
Fourth Planet from the Sun



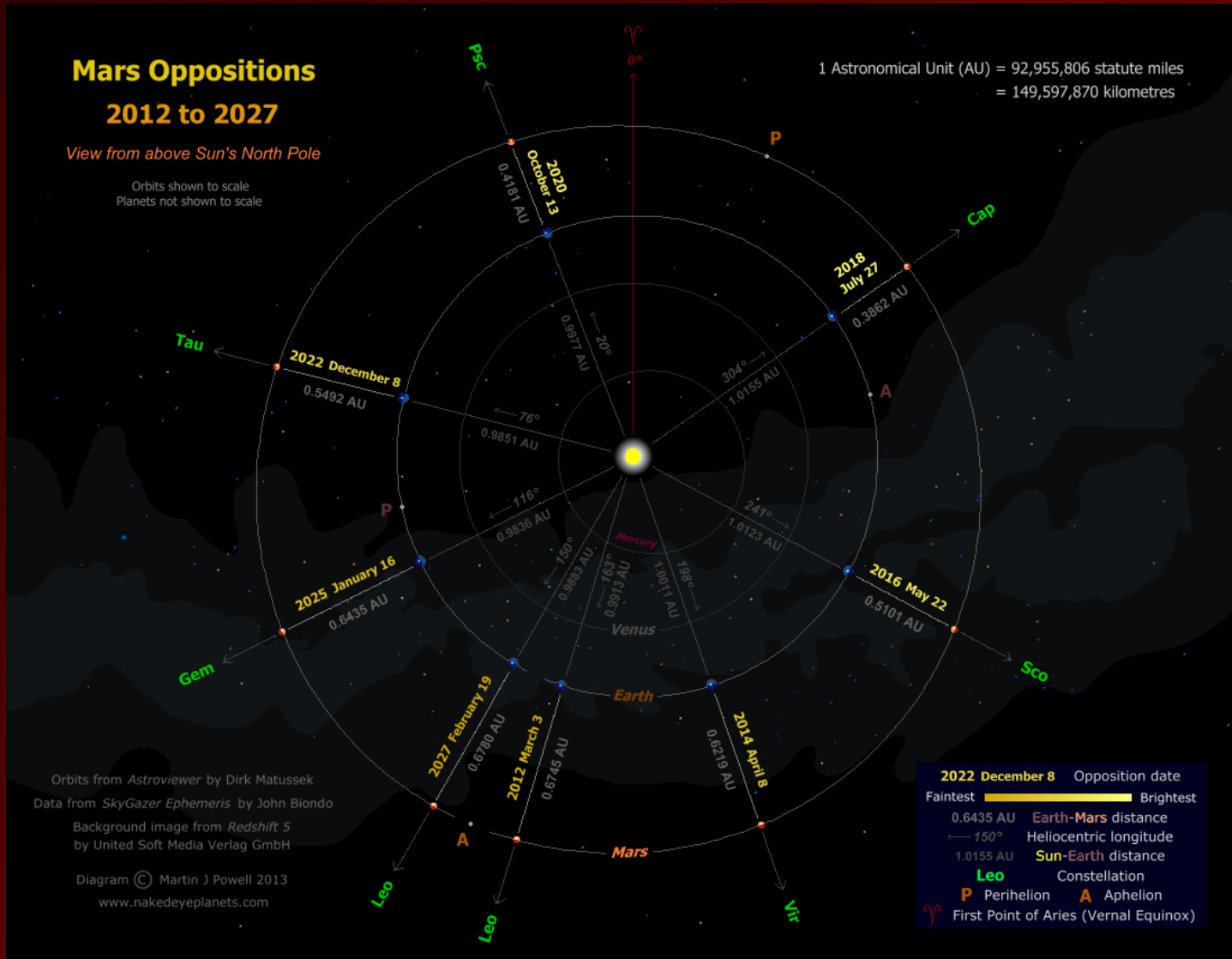
Just a Little Guy



How Far Away Is Mars?



Especially Good Time to See Mars



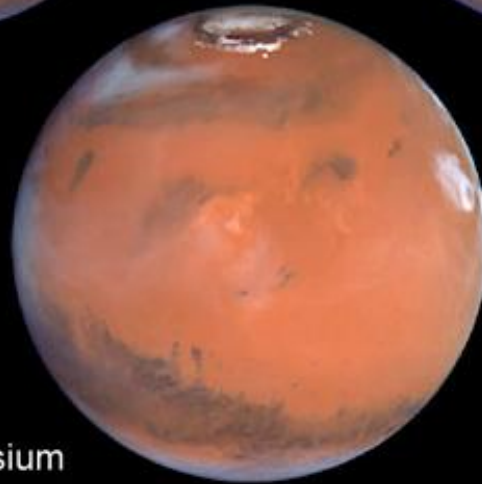
Key Martian Landmarks



Acidalia



Tharsis

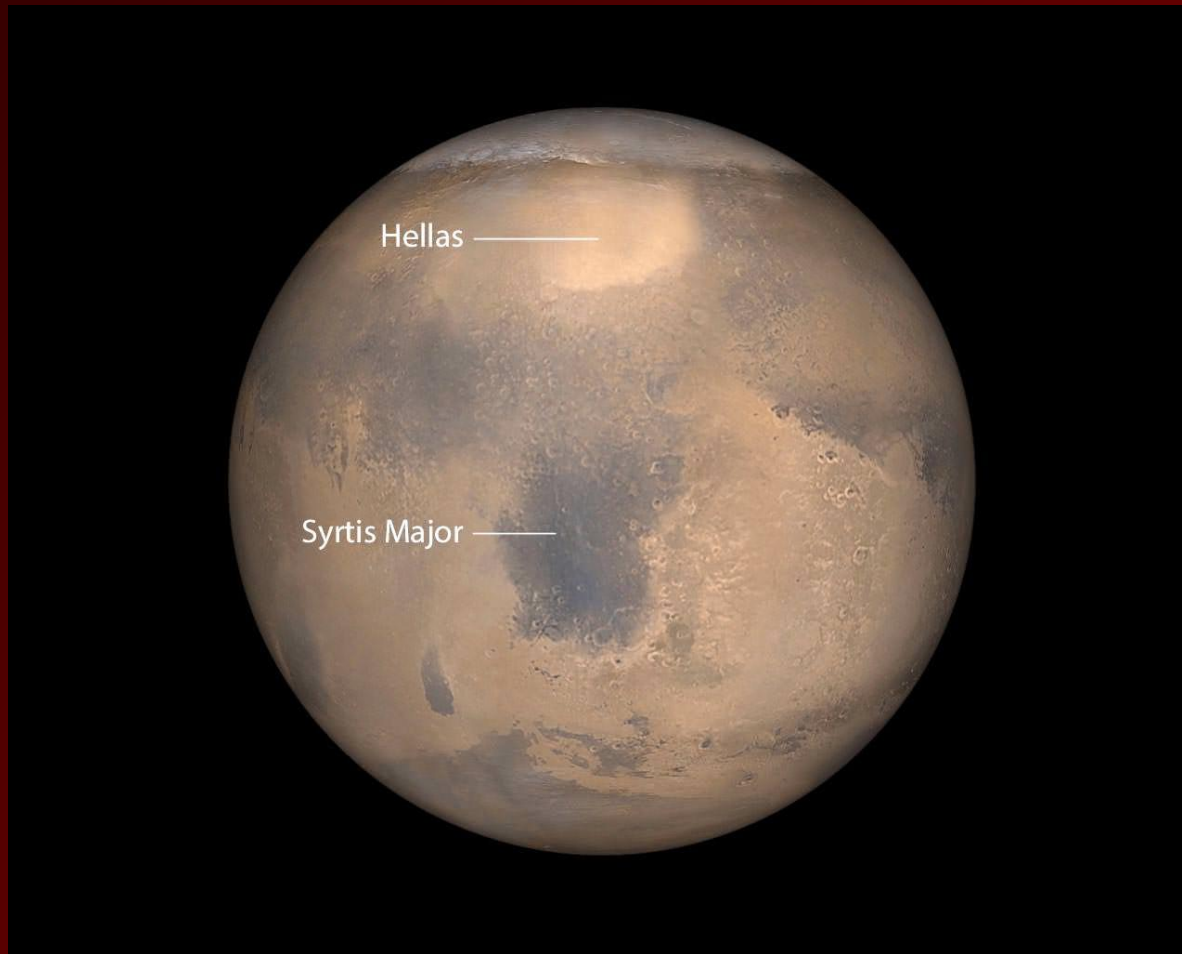


Elysium



Syrtis Major

Syrtis Major & Hellas



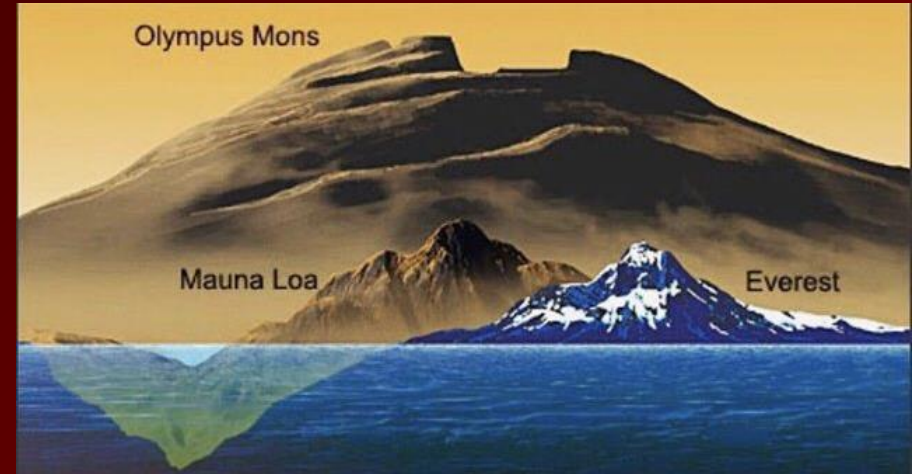
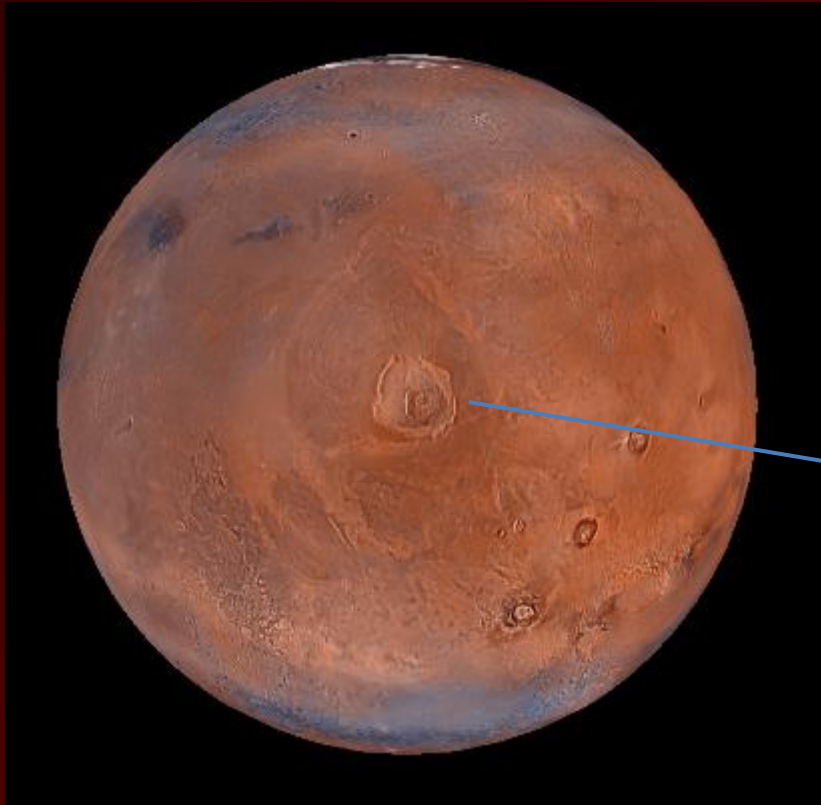
South is Up

Schiaparelli Crater



Sketch by Giovanni Schiaparelli

The Volcanoes



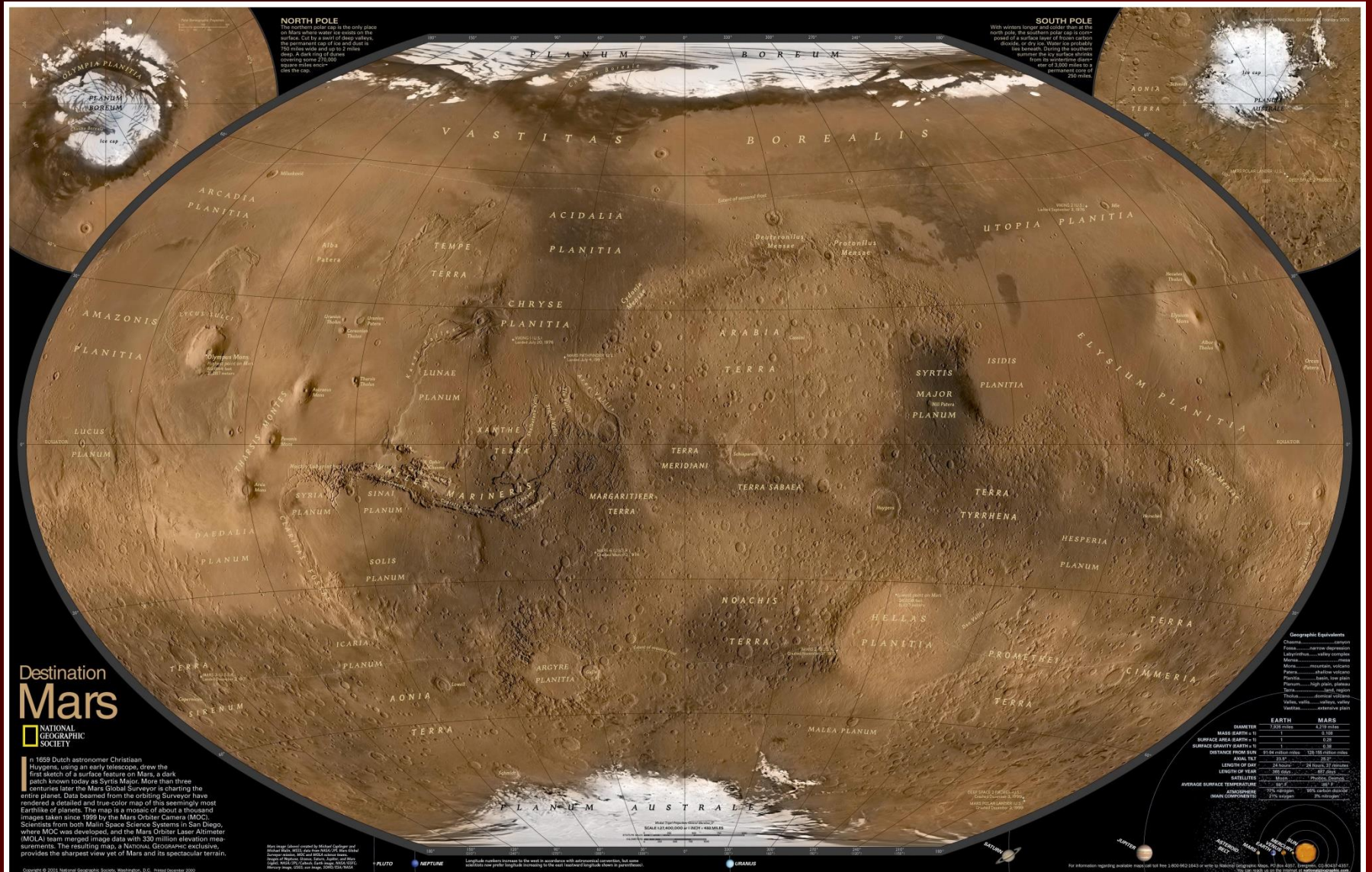
Olympus Mons

- Largest volcano in the solar system
- 3x taller than Everest
- Covers an area the size of France



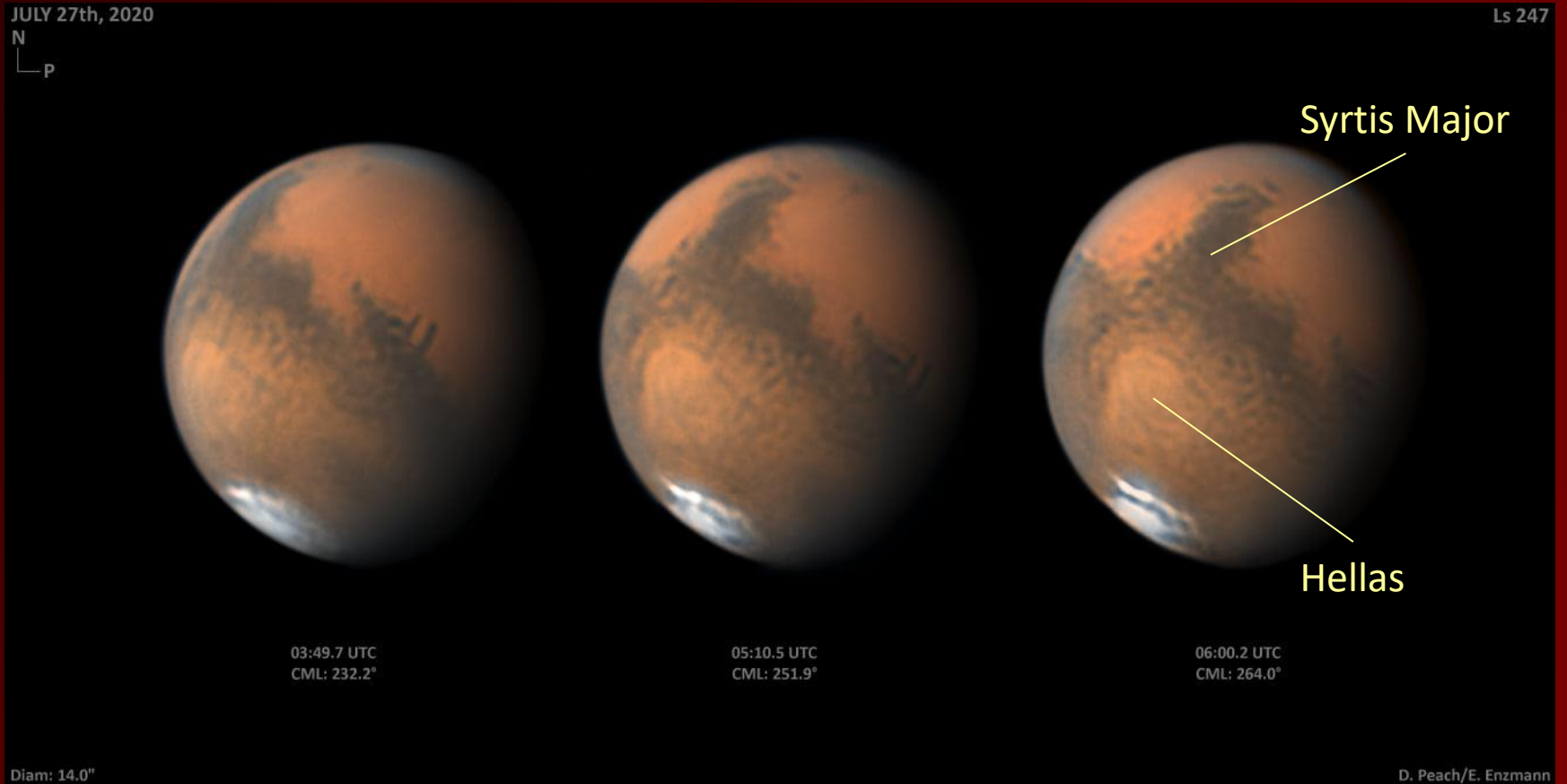
Olympus Mons (Mars),
the largest volcano in
the Solar System
compared to France

Everything All Together

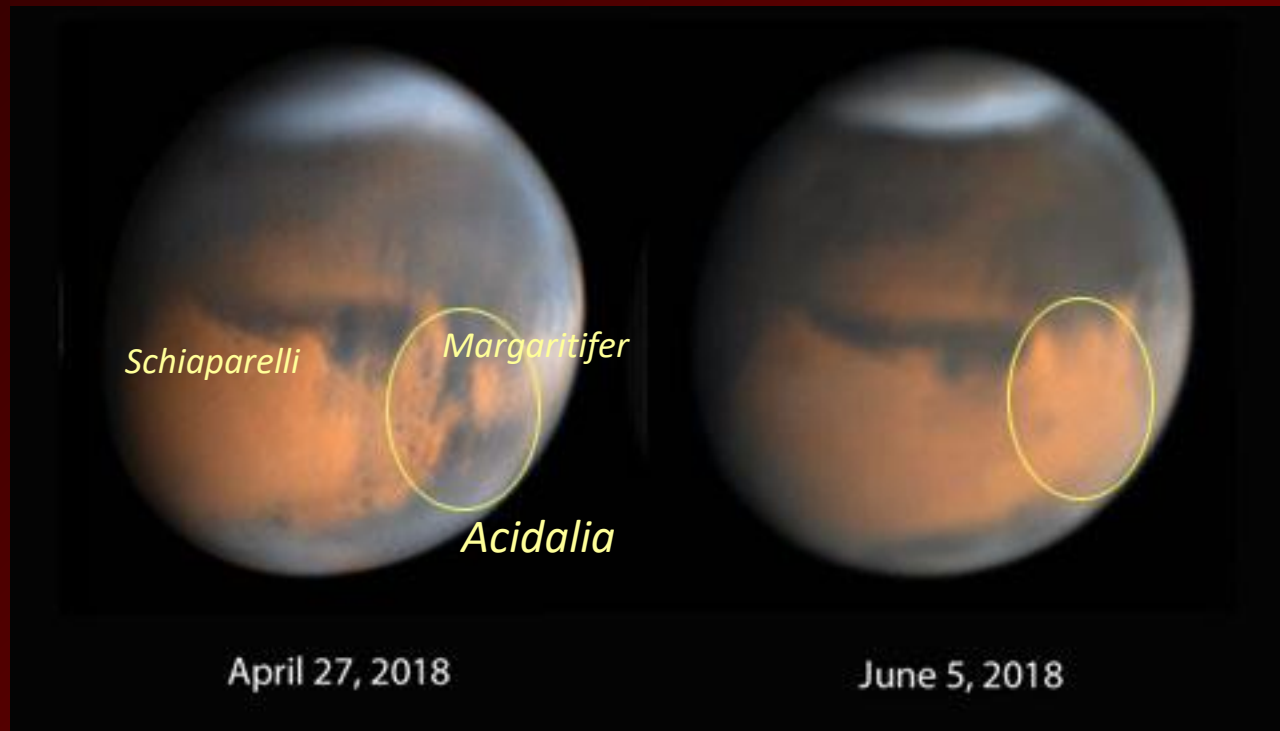


YOUR MARTIAN GEOGRAPHY QUIZ

Where Are We? [1]



Where Are We? [2]



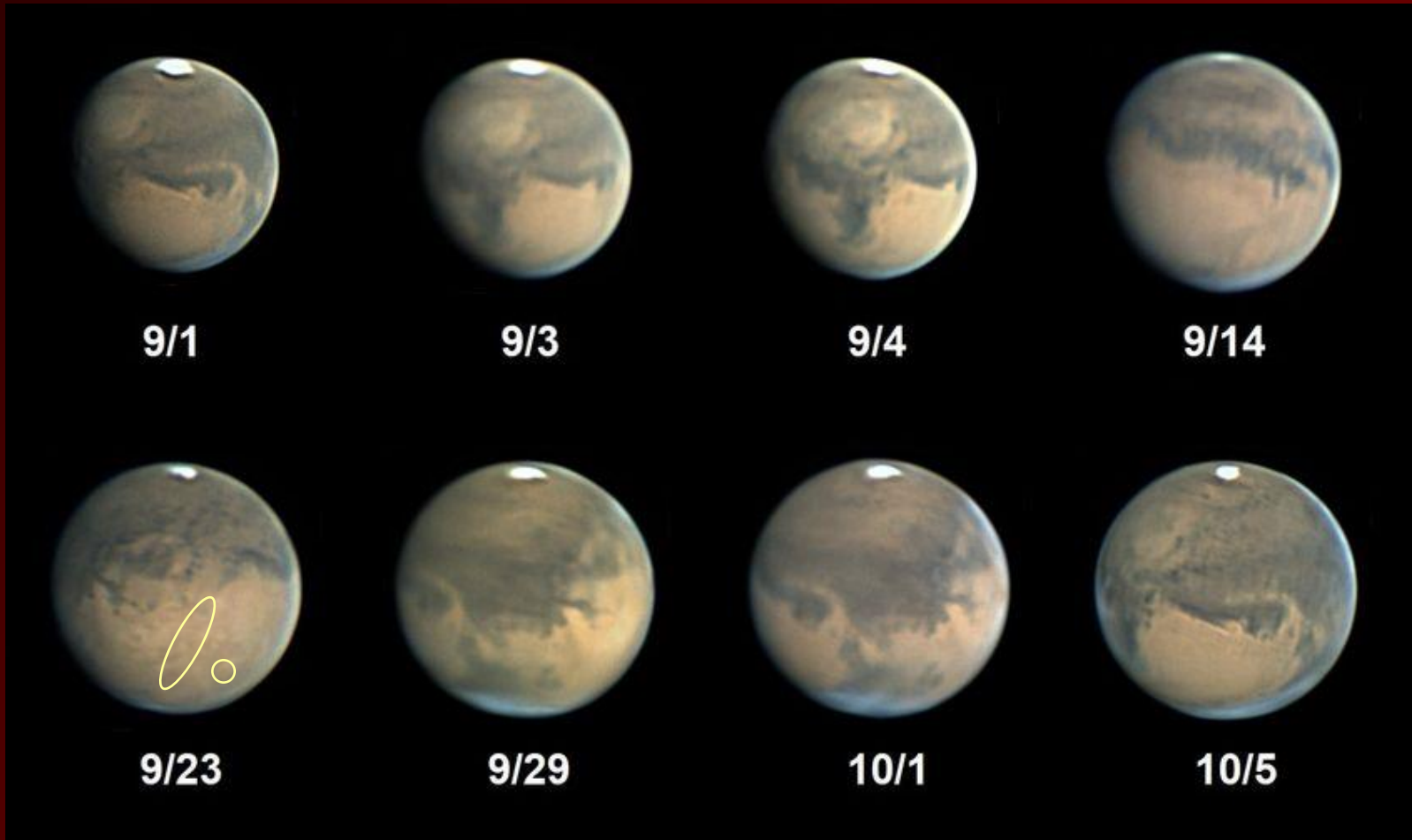
South is Up

Where Are We? [3]



South is Up

Where Are We? [4]



Lee Keith using A-Scope: 12.5 inch f/8.71 Newtonian reflector

Oh, Sure, NOW You Tell Us

skyandtelescope.org

NEW BERLIN, WI, US | SUNSET: 6:52 PM | MOON: 22% WAXING CRESCENT | INTERACTIVE STAR CHART

LOGIN | SHOP AT SKY | SEARCH

NEWS OBSERVING TOOLS **SKY & TELESCOPE** COMMUNITY TOURS MAGAZINE
THE ESSENTIAL GUIDE TO ASTRONOMY

ASTRONOMY & OBSERVING NEWS

SOLAR SYSTEM Race to Venus: How We'll Verify Phosphine
BY: ARWEN RIMMER | SEPTEMBER 16, 2020

SOLAR SYSTEM Potential Biosignature Found in Venus's Clouds
BY: ARWEN RIMMER | SEPTEMBER 14, 2020

PROFESSIONAL TELESCOPES
MOUNT WILSON ESCAPES WILDFIRE; AMATEUR OBSERVATORY DESTROYED
BY: DAVID DICKINSON & SABRINA GARVIN | SEPTEMBER 18, 2020
Firefighting crews held the line as wildfire threatened Mount Wilson; an amateur observatory built by the Tri-Valley Stargazers was not so lucky.

ASTRONOMY IN SPACE WITH DAVID DICKINSON
Amateur Astronomer Finds Kilometer-size Asteroid
BY: DAVID DICKINSON | SEPTEMBER 11, 2020

MILKY WAY
Astronomers Map Andromeda's Halo
BY: MONICA YOUNG | SEPTEMBER 10, 2020

VARIABLE STARS

Mars Profiler - Google Chrome

skyandtelescope.org/wp-content/plugins/observing-tools/mars_profiler/mars.html

SKY & TELESCOPE Mars Profiler

This map depicts the Martian hemisphere facing Earth for the entered date, time, and telescope type. The red circle indicates the region of Mars pointed directly toward us.

Date: 10/20/2020 Time: 01:30 UT
(mm/dd/yyyy)

Reset to current date & time Calculate using entered date and time

-1 Day -1 Hour +1 Hour +1 Day

Time-zone offset from UT in hours (from your Web browser): -5

Telescope type: **Inverted view**

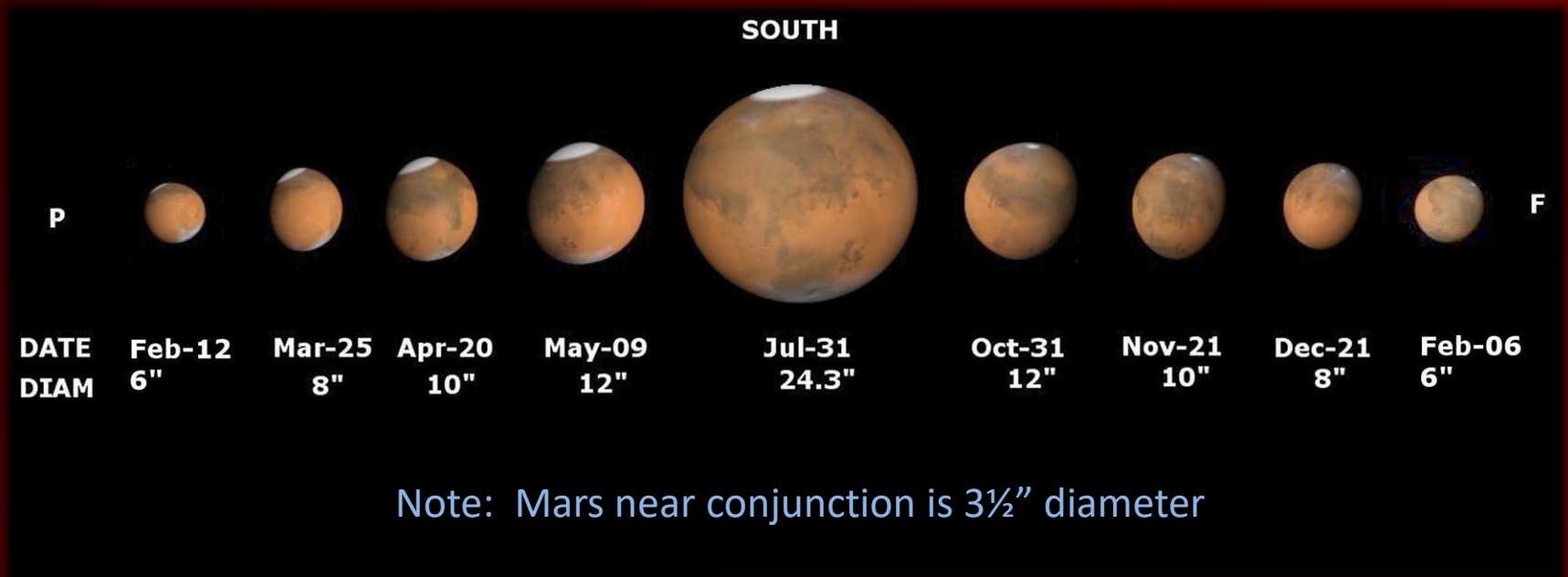
Direct view (Erect-image system) Inverted view (Newtonian / Dobsonian) Mirror reversed (SCT/Mak/refractor + diagonal)

Basic Data about Mars for telescopic observers:

Apparent visual magnitude:	-2.5	Angular diameter (arcsec):	21.8
Distance from Earth (a.u.):	0.43	Elongation from the Sun (°):	172
Illumination (%):	100	Central-meridian longitude (°):	141
Position angle of north pole (°):	326	Opposition 2020 countdown (days):	past

How Much Detail Can I See?

Mars Opposition 2018



Resolving Power of Your Scope

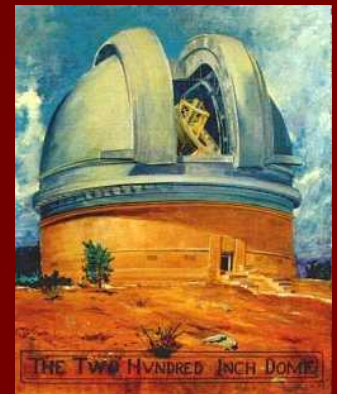
$$P_R = \frac{120}{D_0}$$

P_R is in arc-seconds, with D_0 in mm

Telescope (inches)	Telescope (mm)	P_R (arc-sec)
4	100	1.2
6	150	0.8
10	250	0.5

Sure We Can Breathe, But...

- Atmospheric conditions are described in terms of “transparency” and “seeing”
- Transparency translates to the faintest star that can be seen
- Seeing indicates the resolution that the atmosphere allows due to turbulence
- Typical is 2-3 arcseconds, a good night is 1 arcsec, Mt. Palomar might get 0.4.

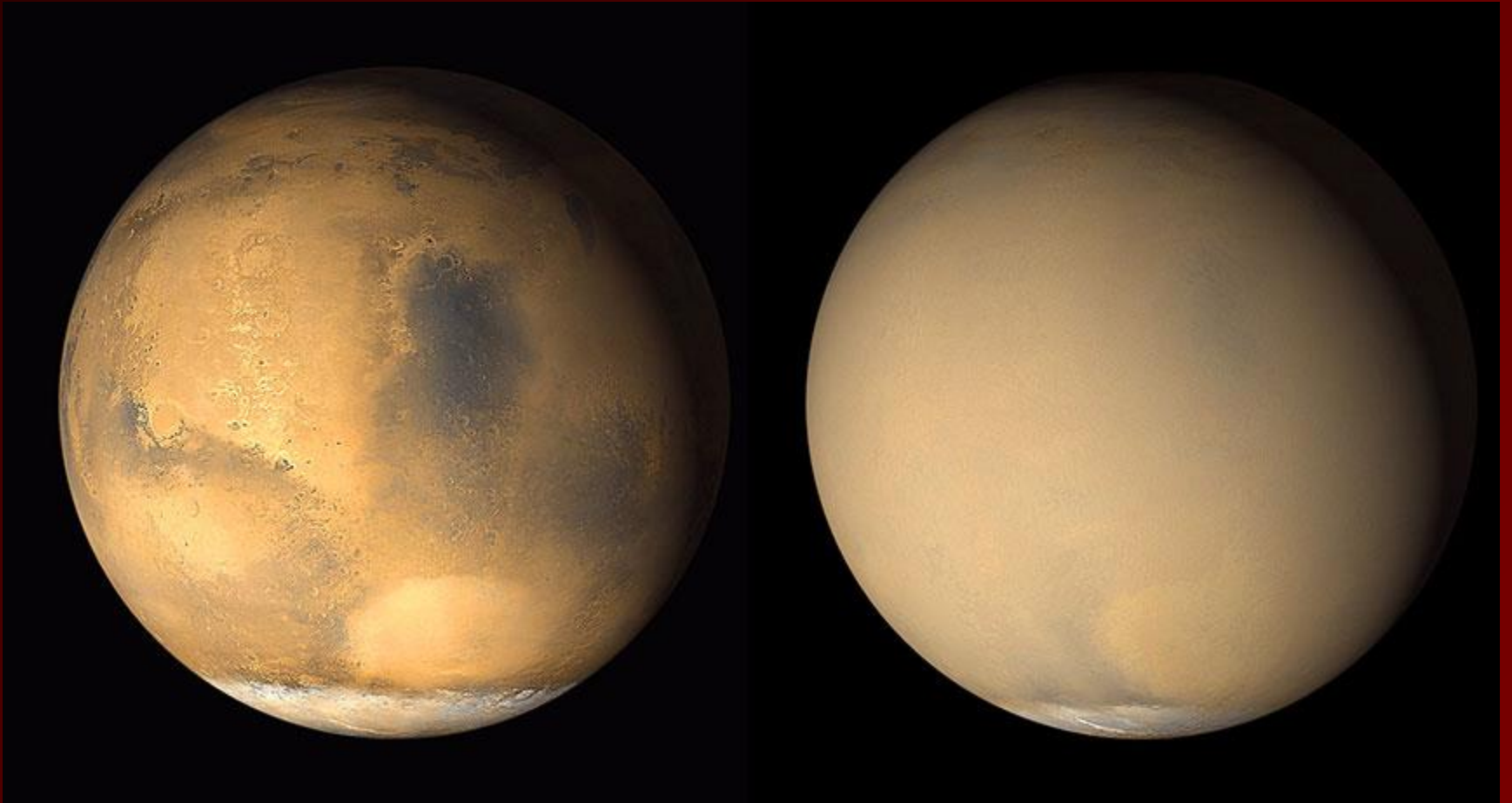


The View in the Scope



*Shot taken by
Ron Lundgren*

Hope for Good Weather

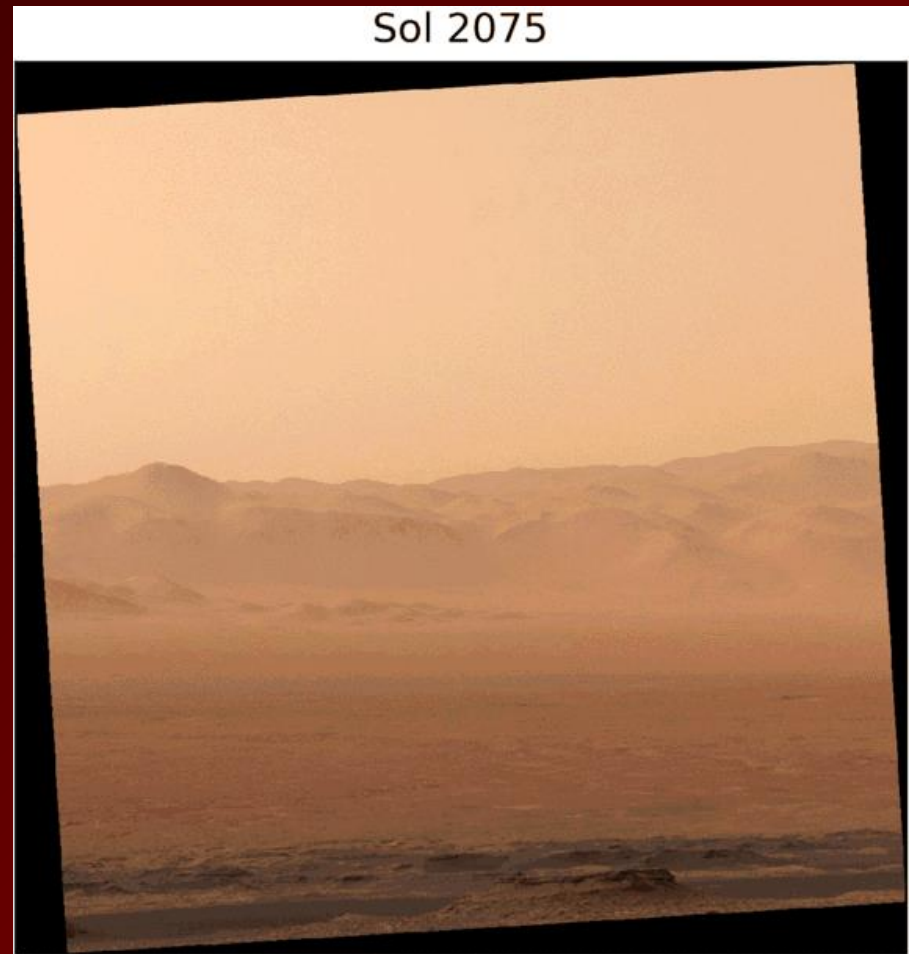


Not just on our planet...

What Did That Look Like on Mars?



Curiosity Rover



June 8, 2018 to Sept. 13, 2018

What's It Like 'Outside' on Mars?

- 96% CO₂, 2% Nitrogen, 2% Argon
- Daily pressure around 6 - 7 mbars
 - Compare to Earth's average 1013 mbars at sea level
 - Less than 0.1 psi (Earth is 14.7 psi)
- Average -80°F
 - around -200°F at the poles
 - can get up to around 70°F at the equator
- Winds around 10-20 mph
 - up to 70 mph during dust storms
- Winds up to 200 mph inside dust devils

Land of Dust Devils

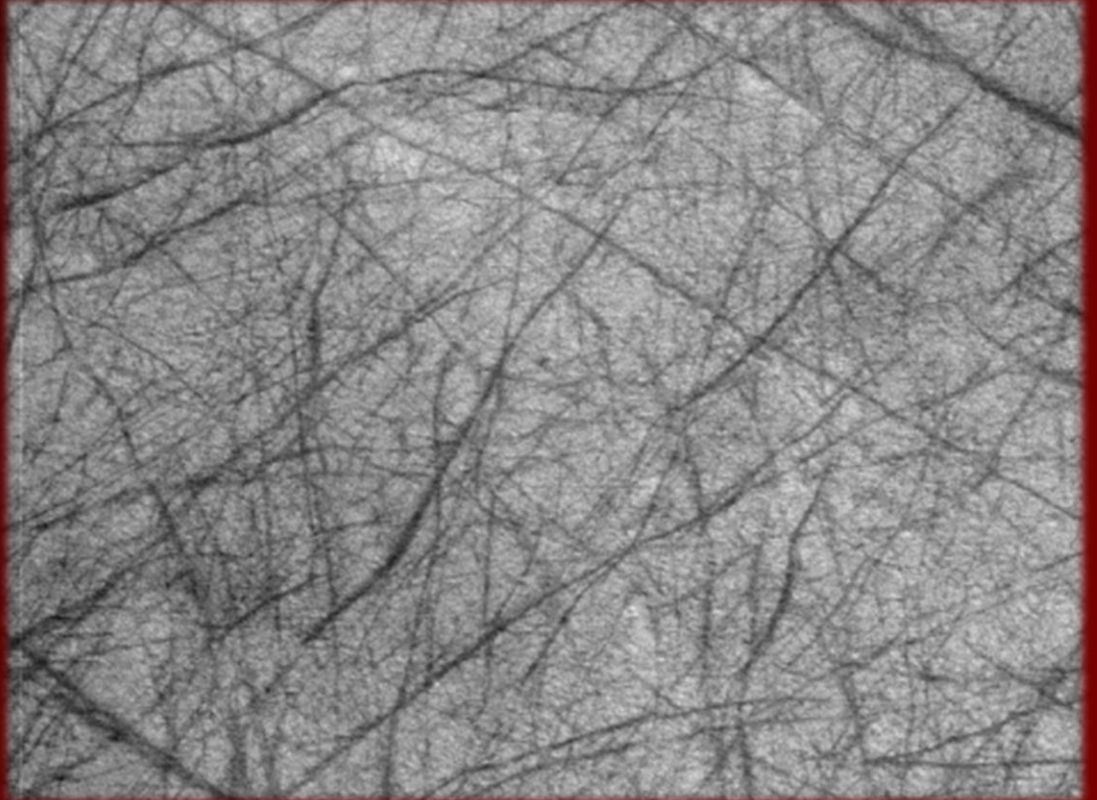


0000



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Dust Devil Tracks

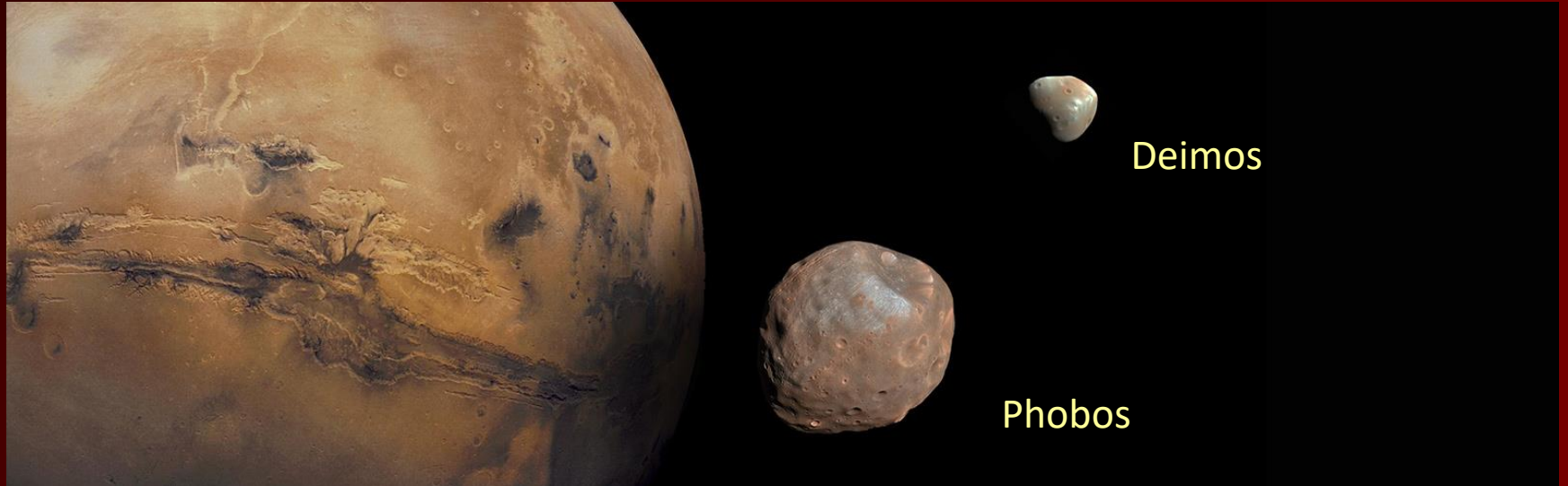


Dust Devil: View from Above

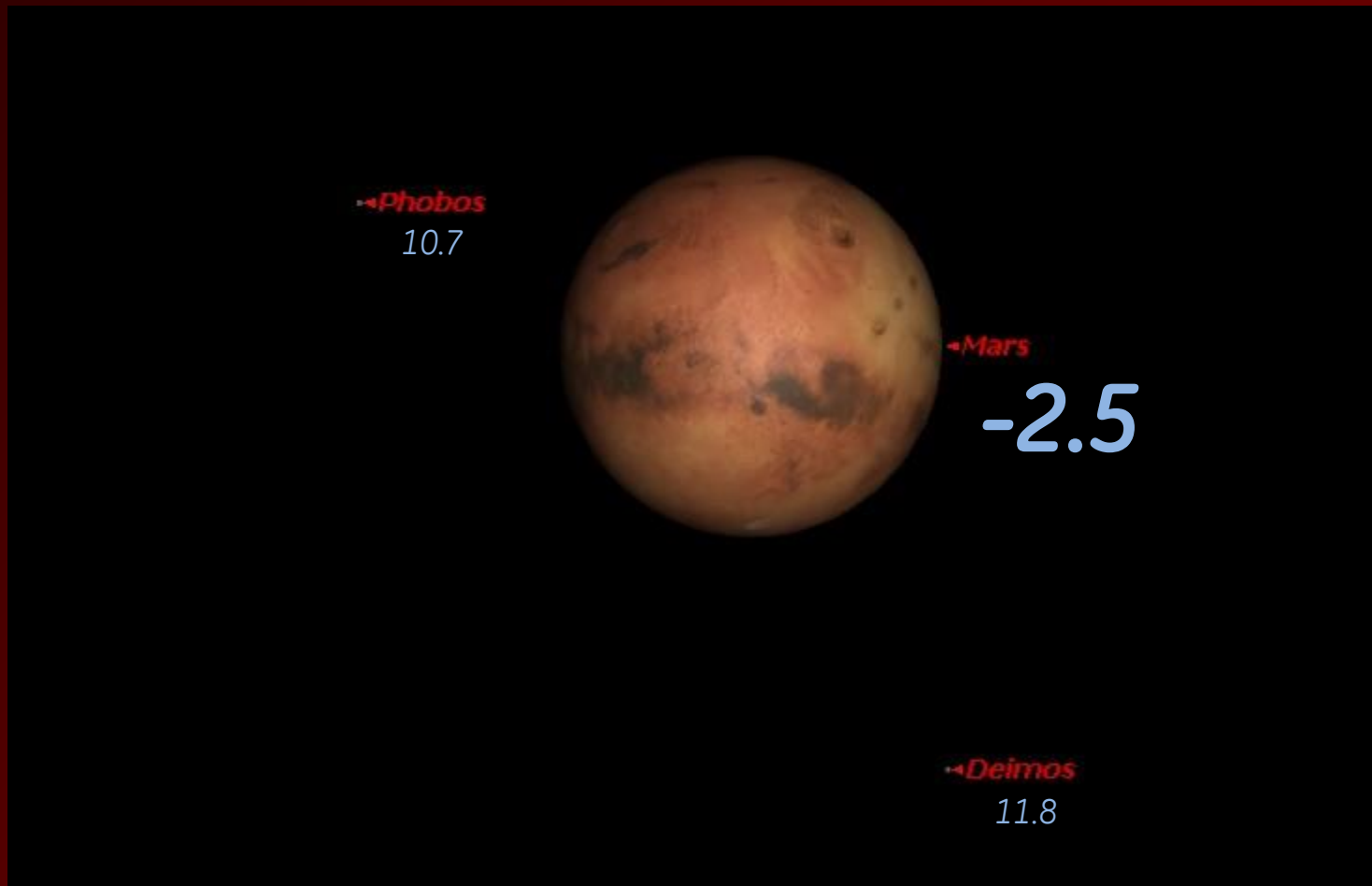


Mars Reconnaissance Orbiter

Doesn't Mars Have Moons?



...And Can I See Them?



As Seen from Mars

Deimos & Phobos from Mars



Deimos Eclipsed by Phobos
as seen by Curiosity



Compared to the Moon from Earth

Getting to Mars

Really the ad for going to Mars would be like Shackleton's ad for going to the Antarctic [in 1914]. It's gonna be hard. There's a good chance of death, going in a little can through deep space. You might land successfully. Once you land successfully, ... there's a good chance you'll die there. We think you can come back; but we're not sure. – Elon Musk



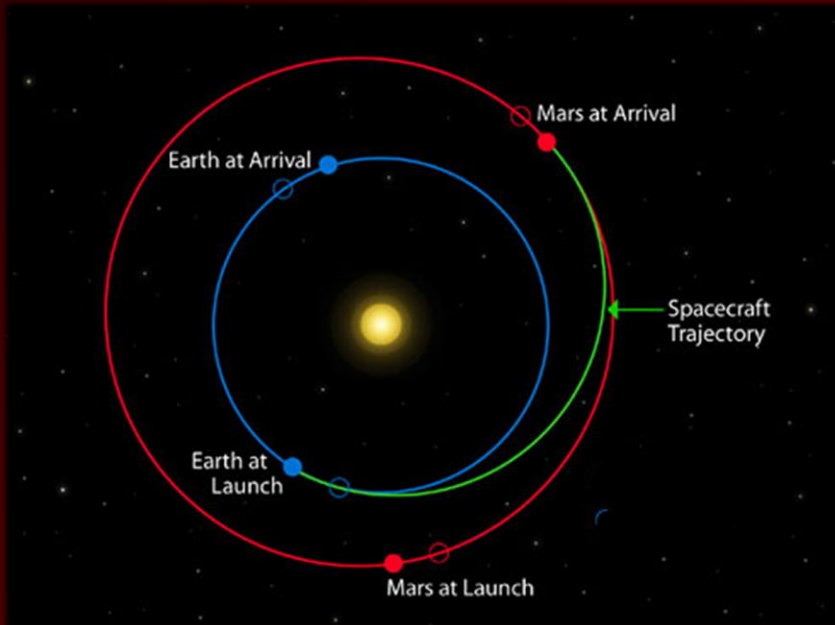
Your Starship



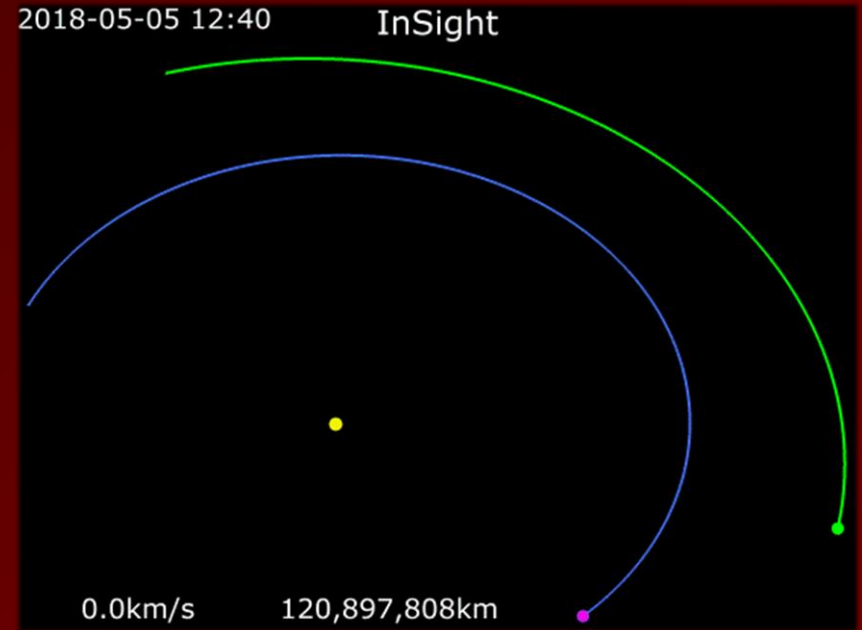
Comparison to Saturn V



Transfer Orbit

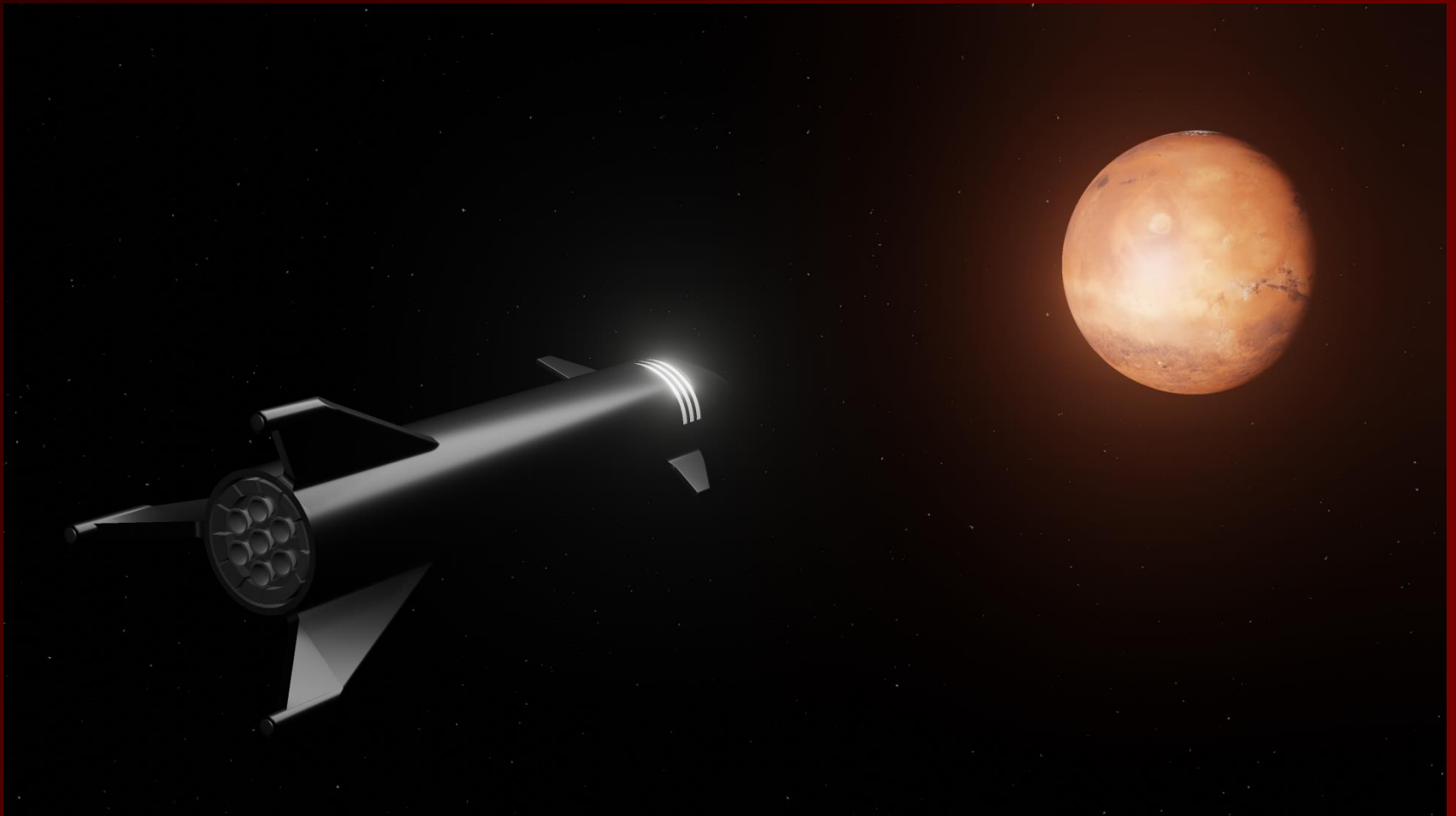


Spirit's & Opportunity's Journeys to Mars



InSight's Journey to Mars

Mars Approach



Mars Entry



Landing First Supply Ship



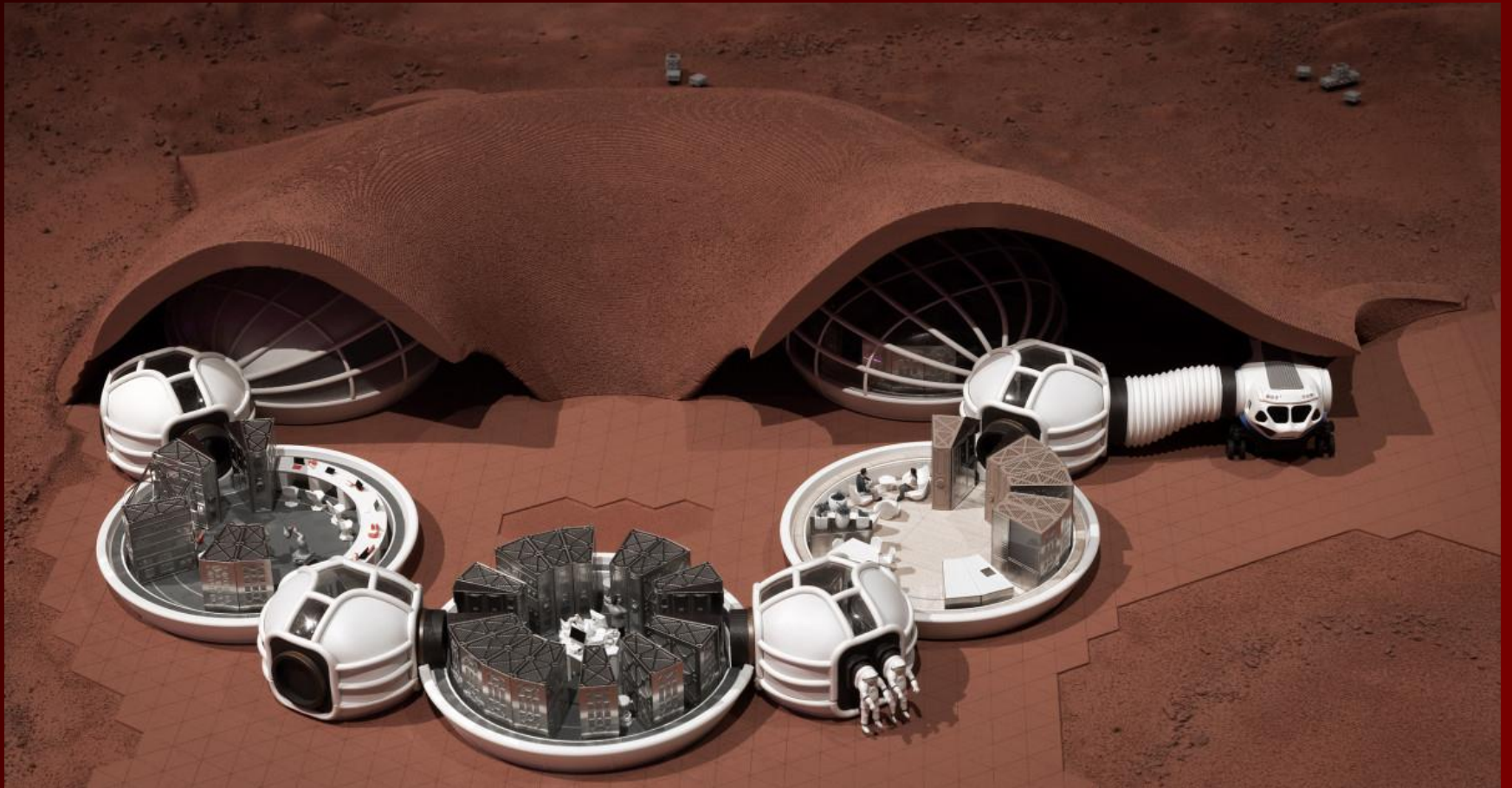
3D Printing the Shelters



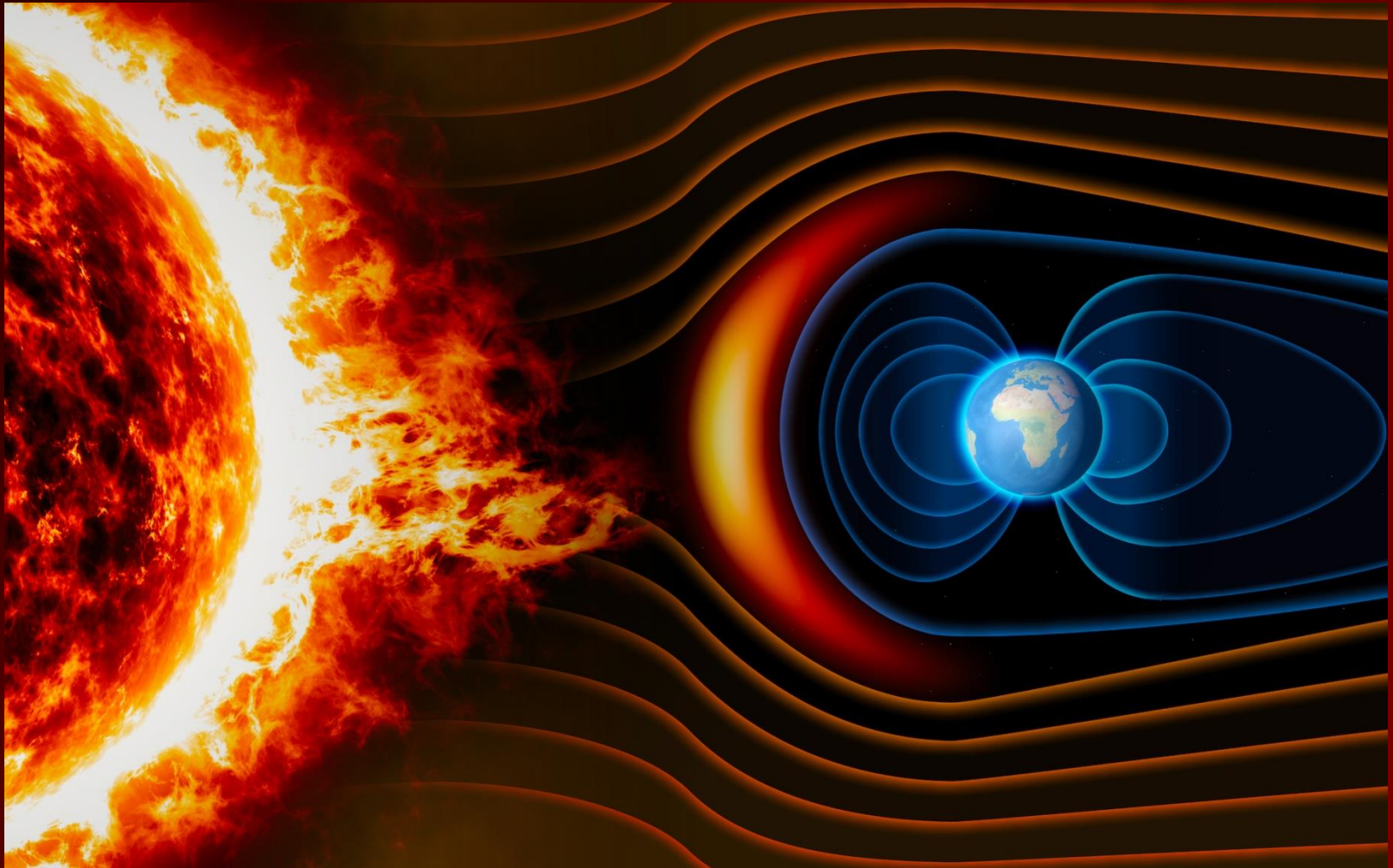
Pressurized Habitat



Habitats Under Shelter



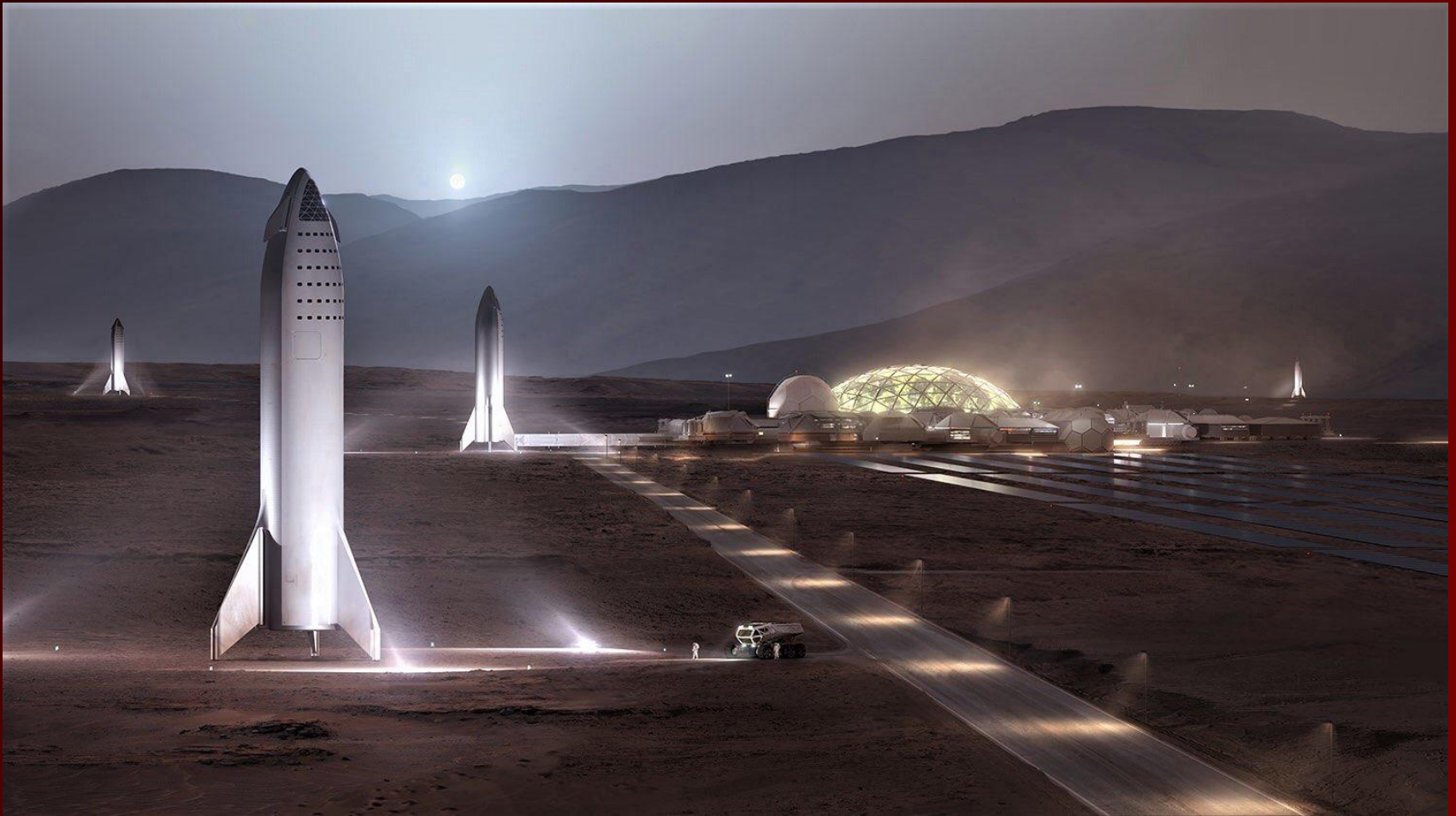
Protective Magnetic Field



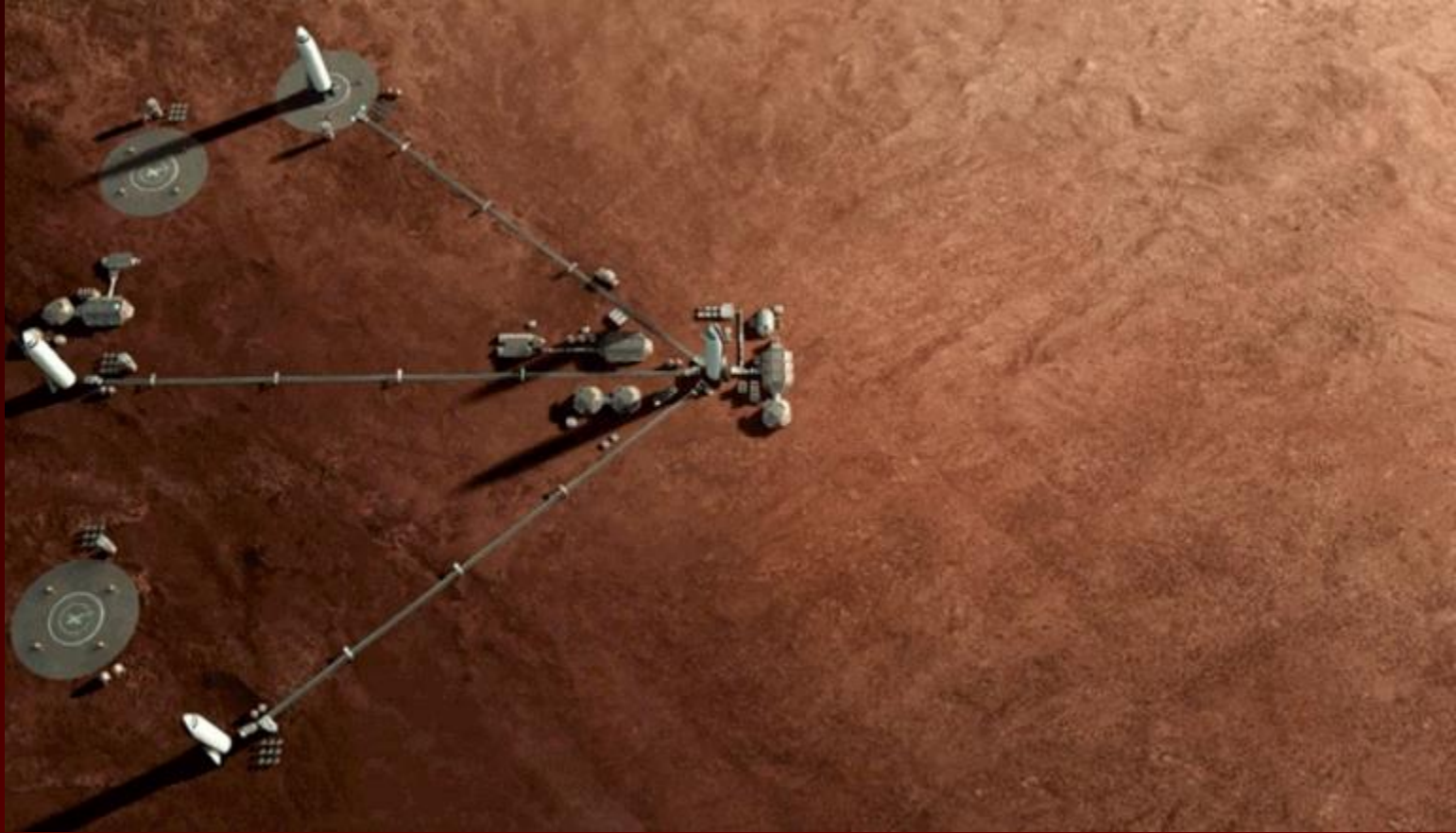
Completed Mars Residence



Establishing a Mars Base



Building a Mars Colony



FIN



APPENDIX

MARSHA Design Habitat



Tera

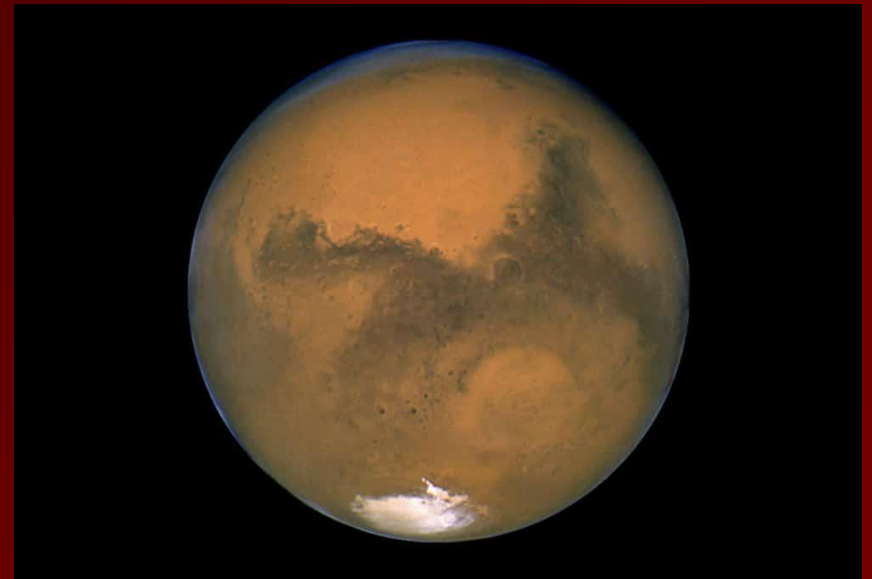


Syrtis Major on 30 September



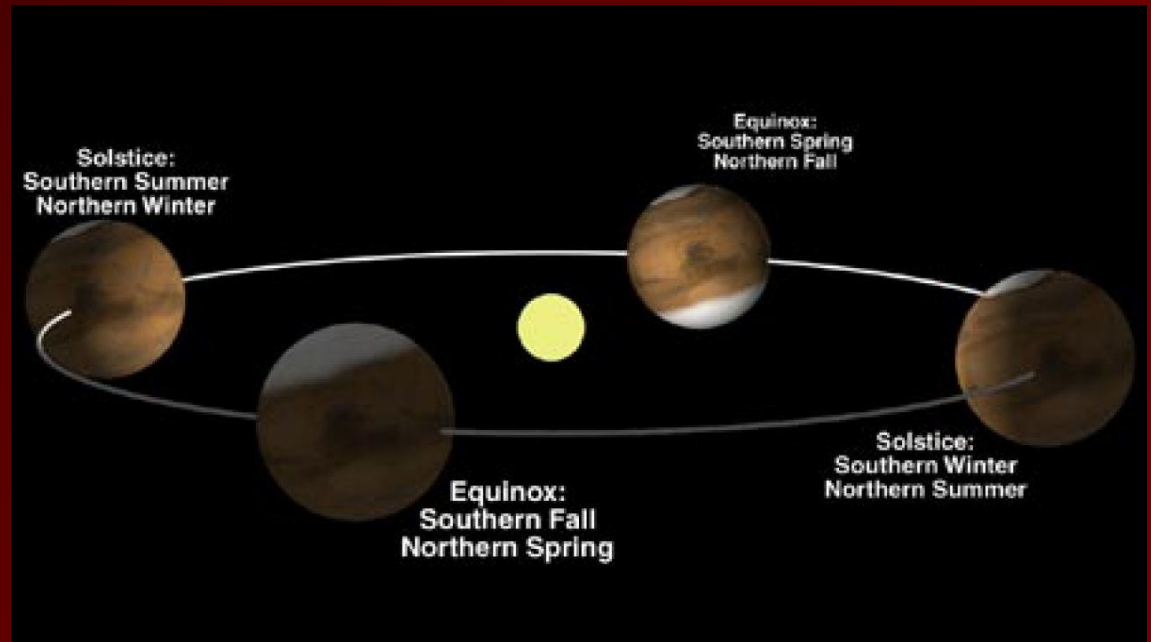
Which Polar Cap Is That?

North Polar Cap



South Polar Cap

Mars Seasons



Mars & Earth Seasons

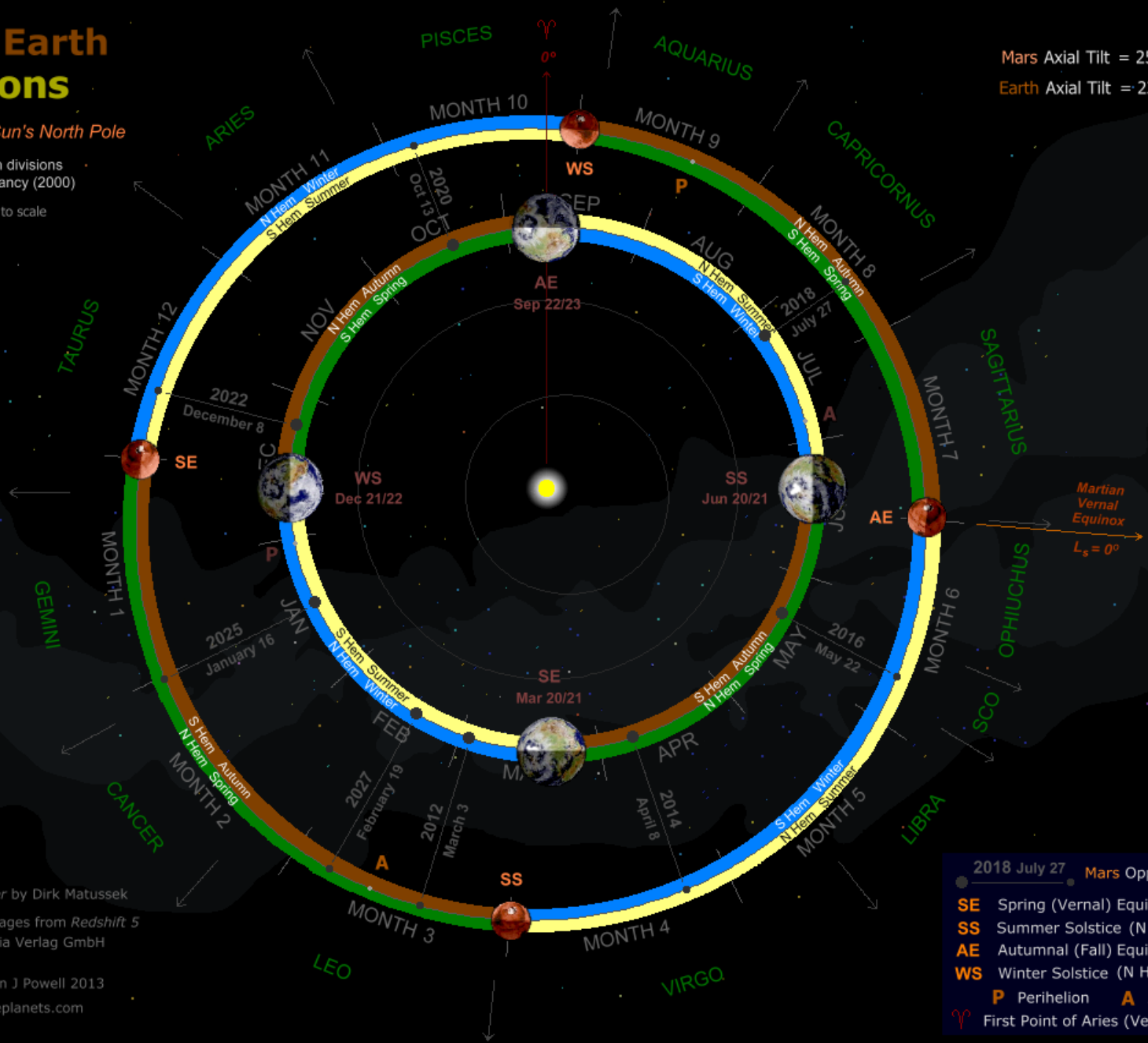
View from above Sun's North Pole

Martian Month divisions after R Todd Clancy (2000)

Orbits shown to scale

Mars Axial Tilt = 25°.19

Earth Axial Tilt = 23°.44

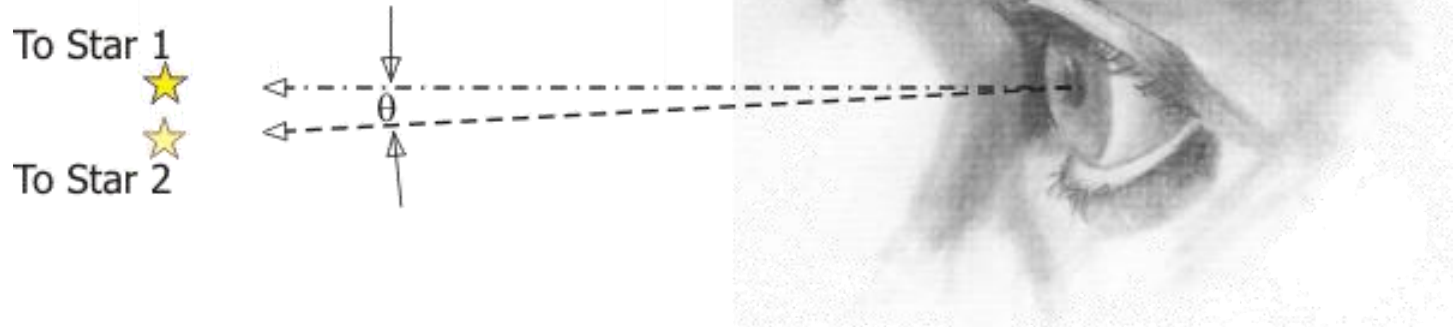


Orbits from *Astroviewer* by Dirk Matussek
 Background & Planet images from *Redshift 5*
 by United Soft Media Verlag GmbH

Diagram © Martin J Powell 2013
www.nakedeyeplanets.com

- 2018 July 27 Mars Opposition date
- SE Spring (Vernal) Equinox (N Hem)
- SS Summer Solstice (N Hem)
- AE Autumnal (Fall) Equinox (N Hem)
- WS Winter Solstice (N Hem)
- P Perihelion A Aphelion
- ♈ First Point of Aries (Vernal Equinox)

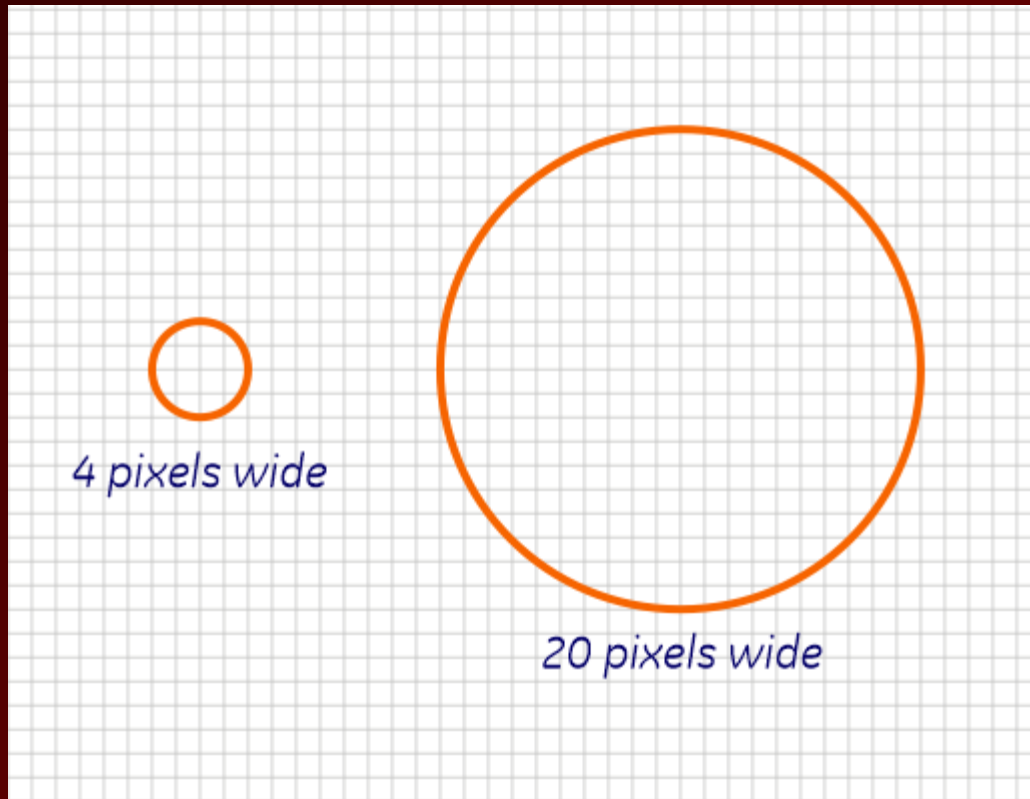
Separation in Arc-Seconds



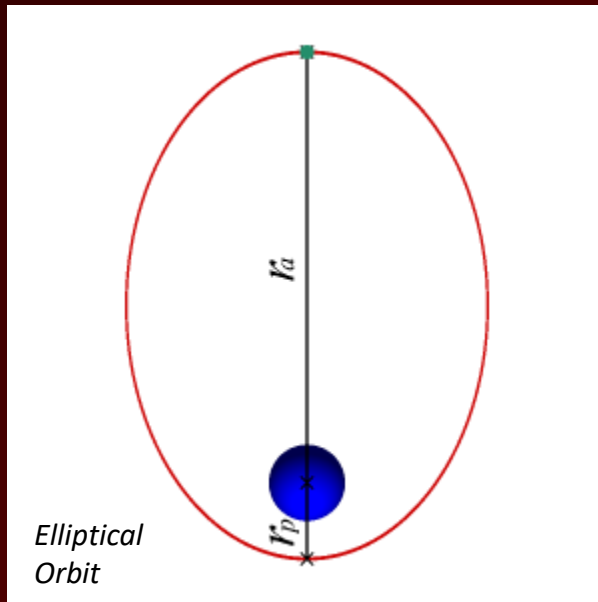
- Separation of stars is expressed as an angle.
- One degree = 60 arc-minutes
- One arc-minute = 60 arc-seconds
- Separation between stars is usually expressed in arc-seconds



Size Matters

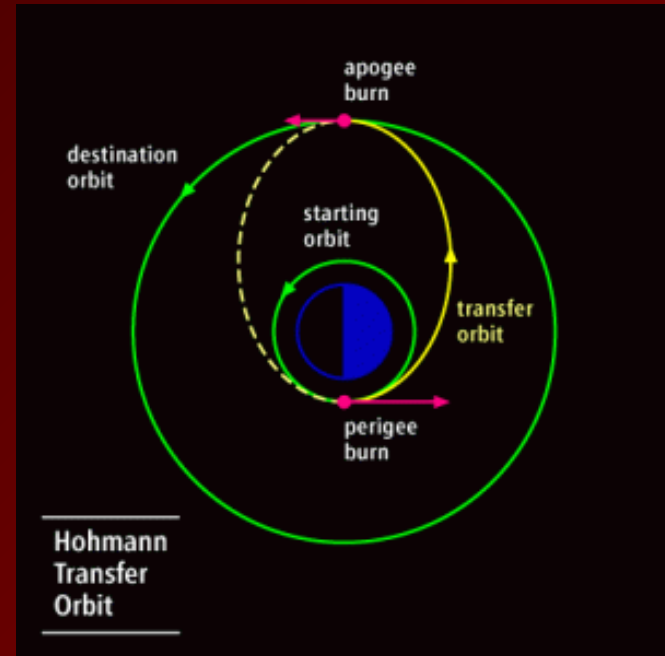


How to Change Your Orbit

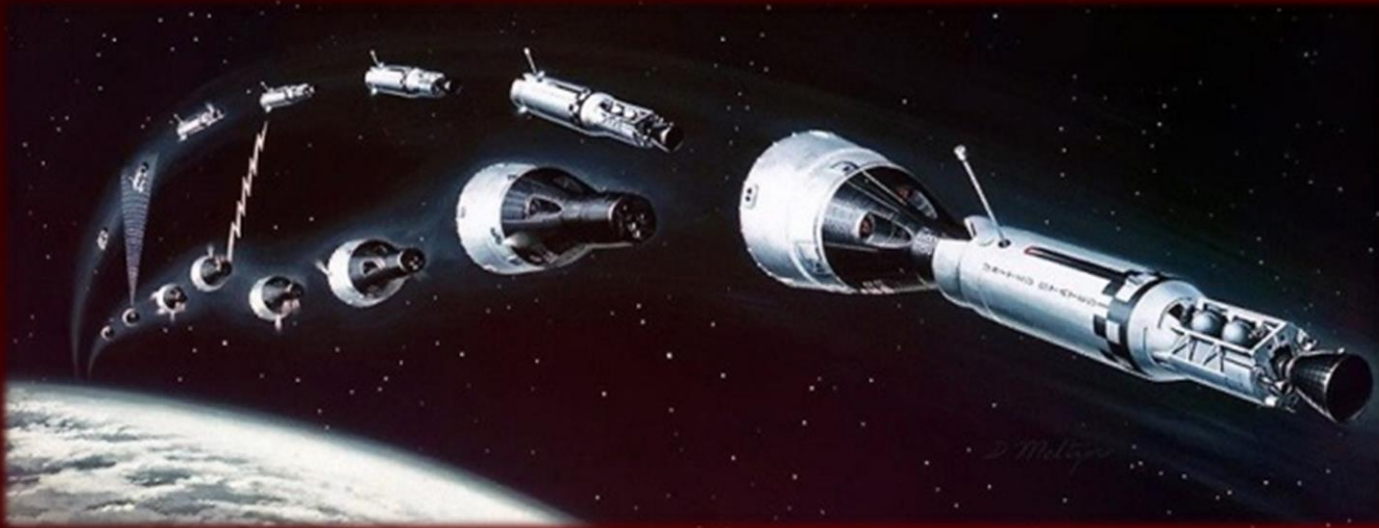


r_a = Apogee (high point)

r_p = Perigee (low point)



Orbital Paradox



Starship on the Launch Pad

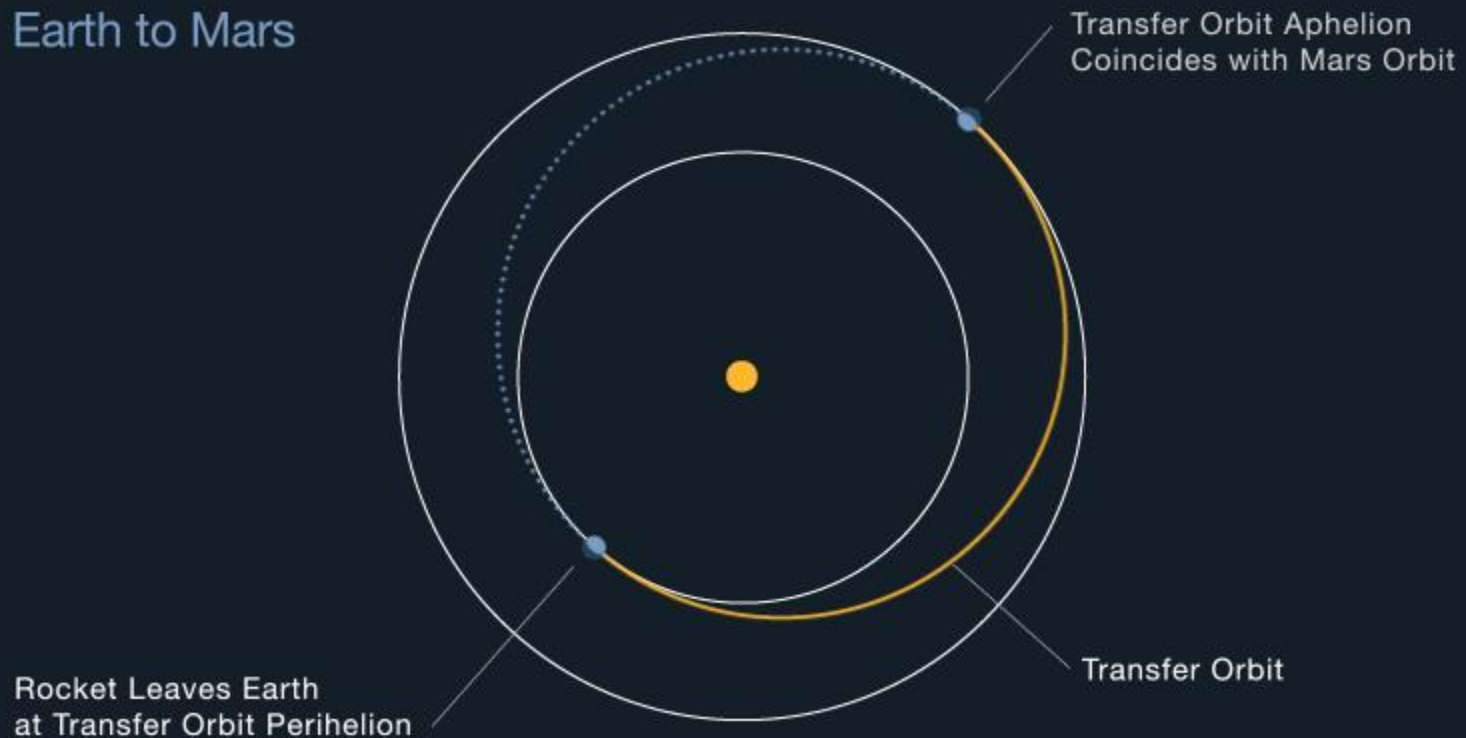


Starship Launch



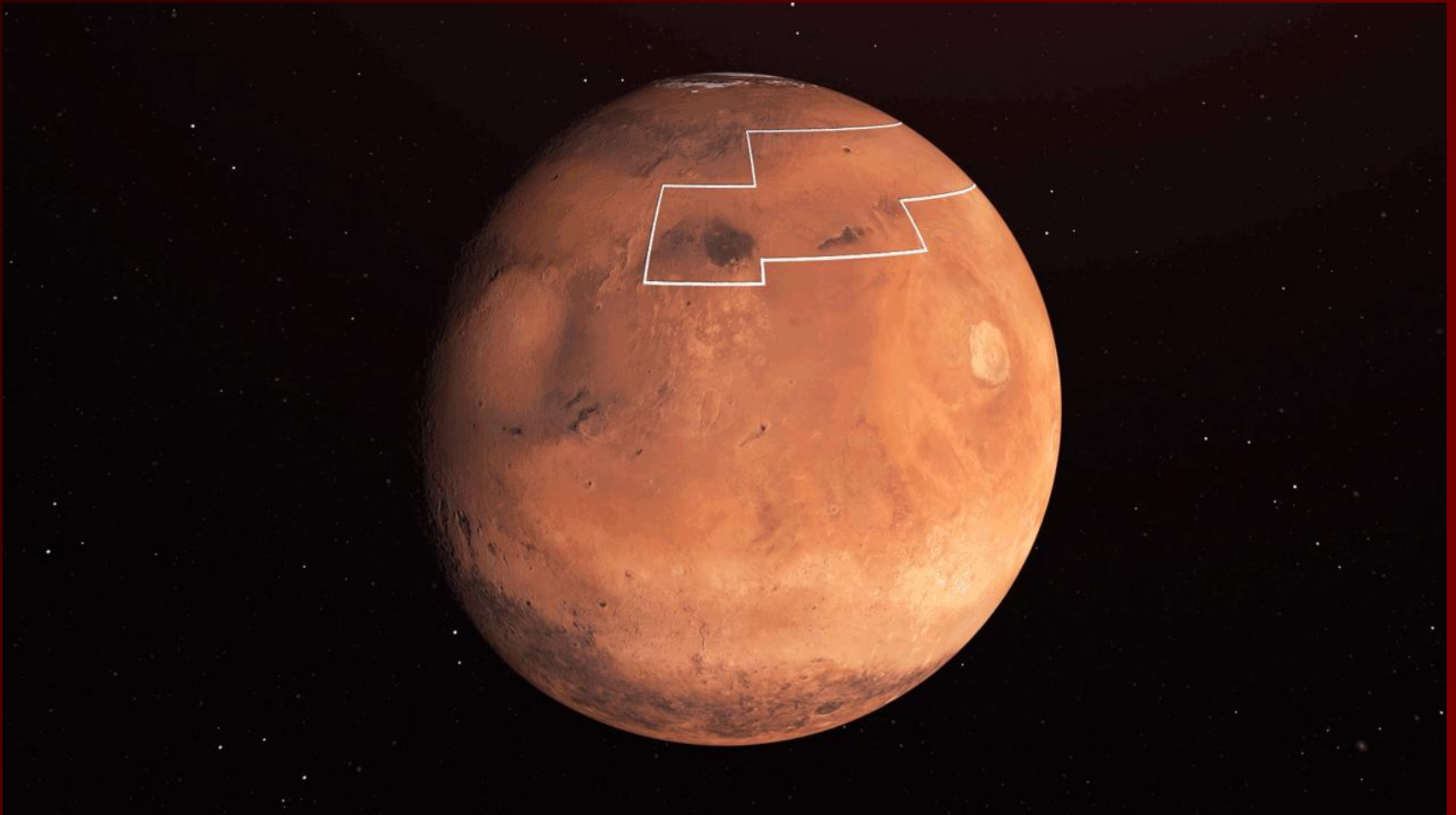
Mars Transfer Orbit

Earth to Mars

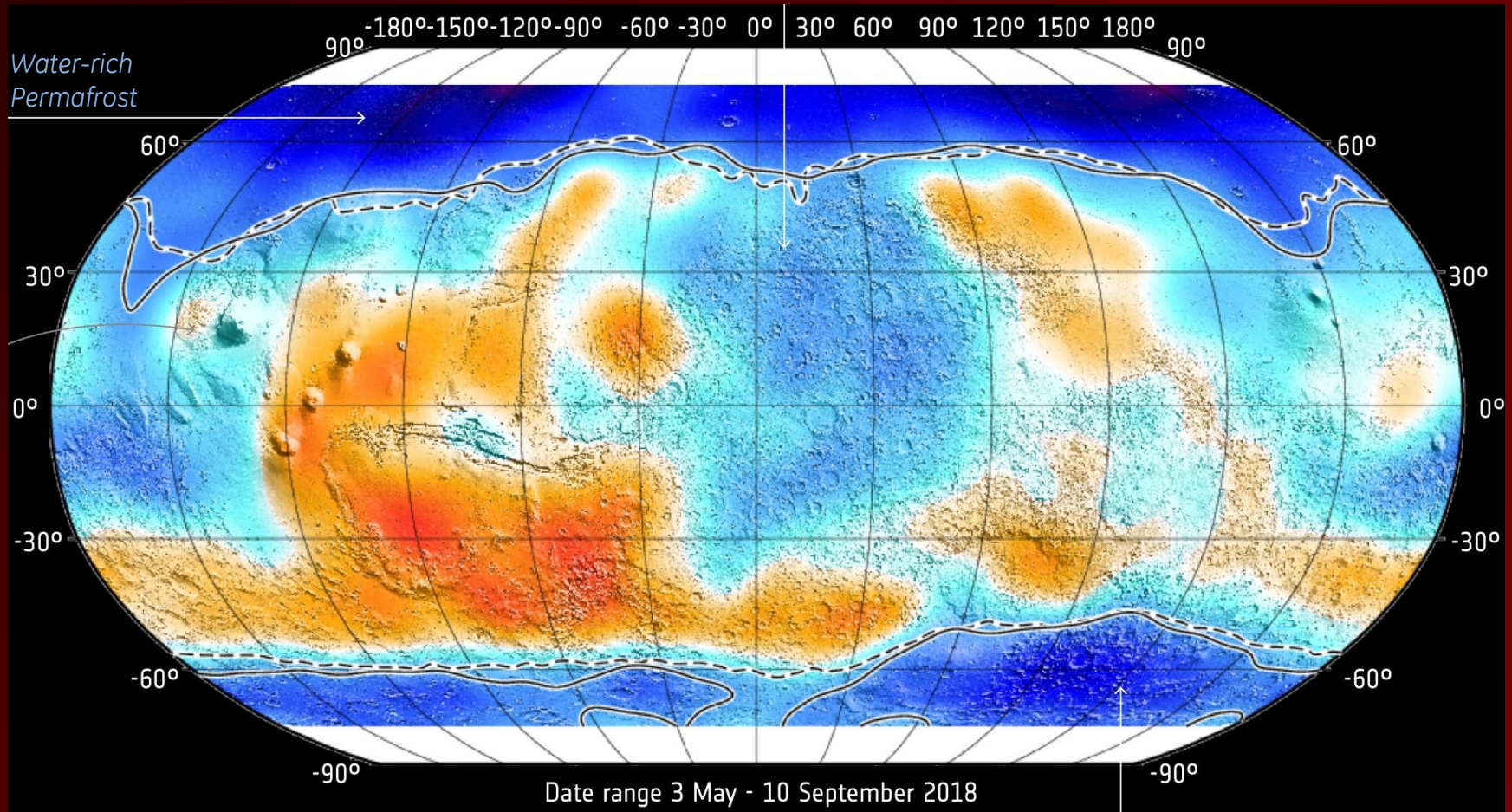


Nine-Month Trip – One Way

Aiming for Water Deposits



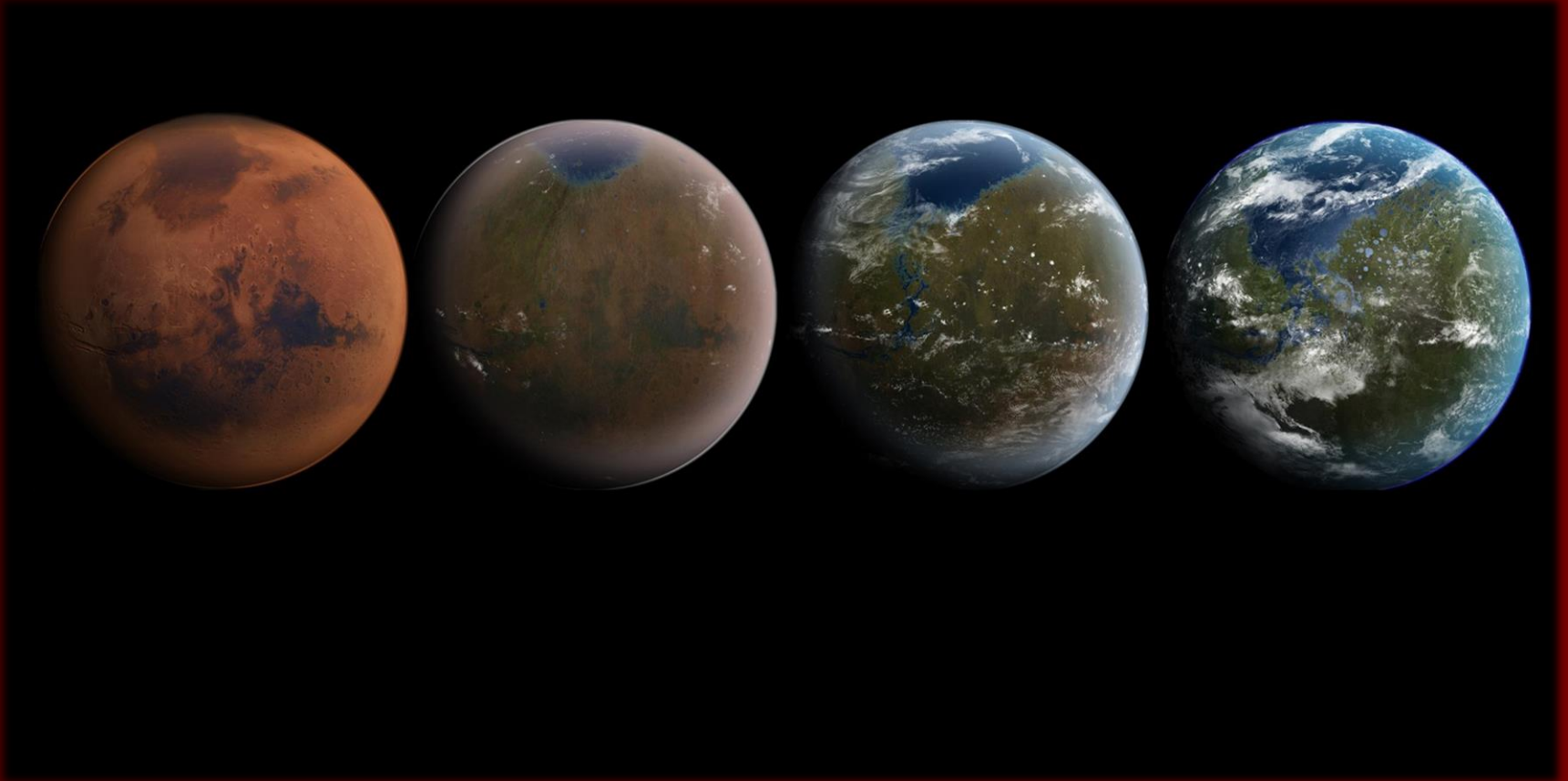
Water Deposits on Mars



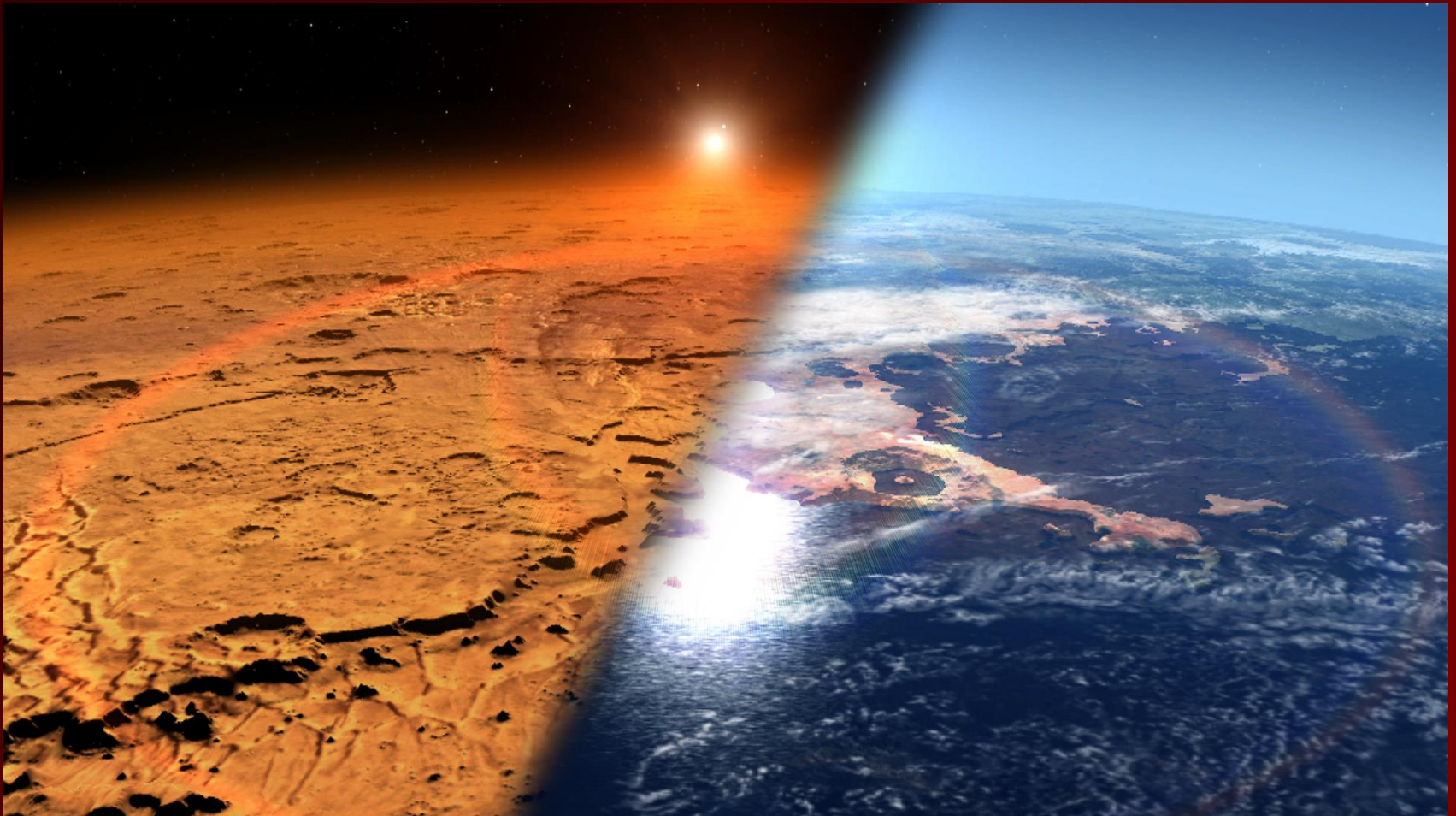
Greenhouse Farms



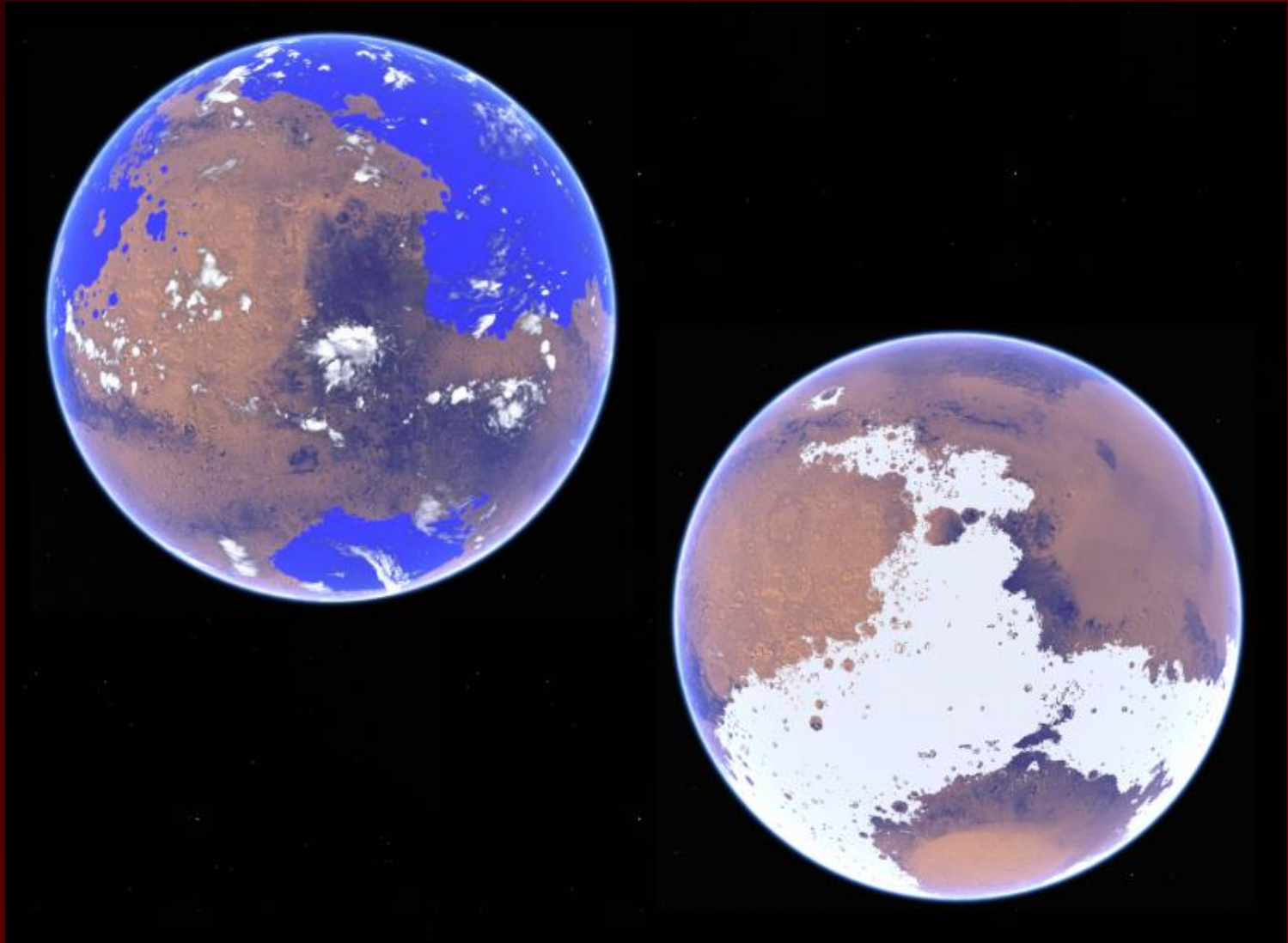
Terraforming Mars



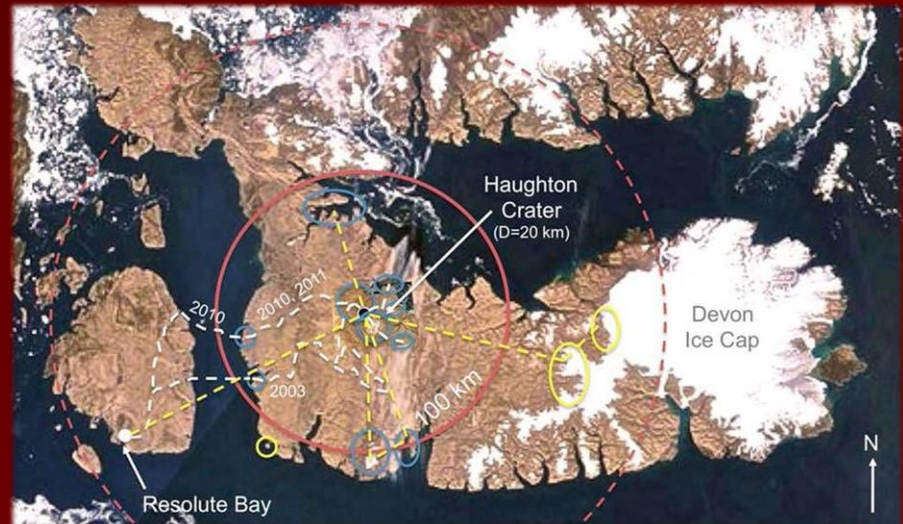
Mars Ocean Hypothesis



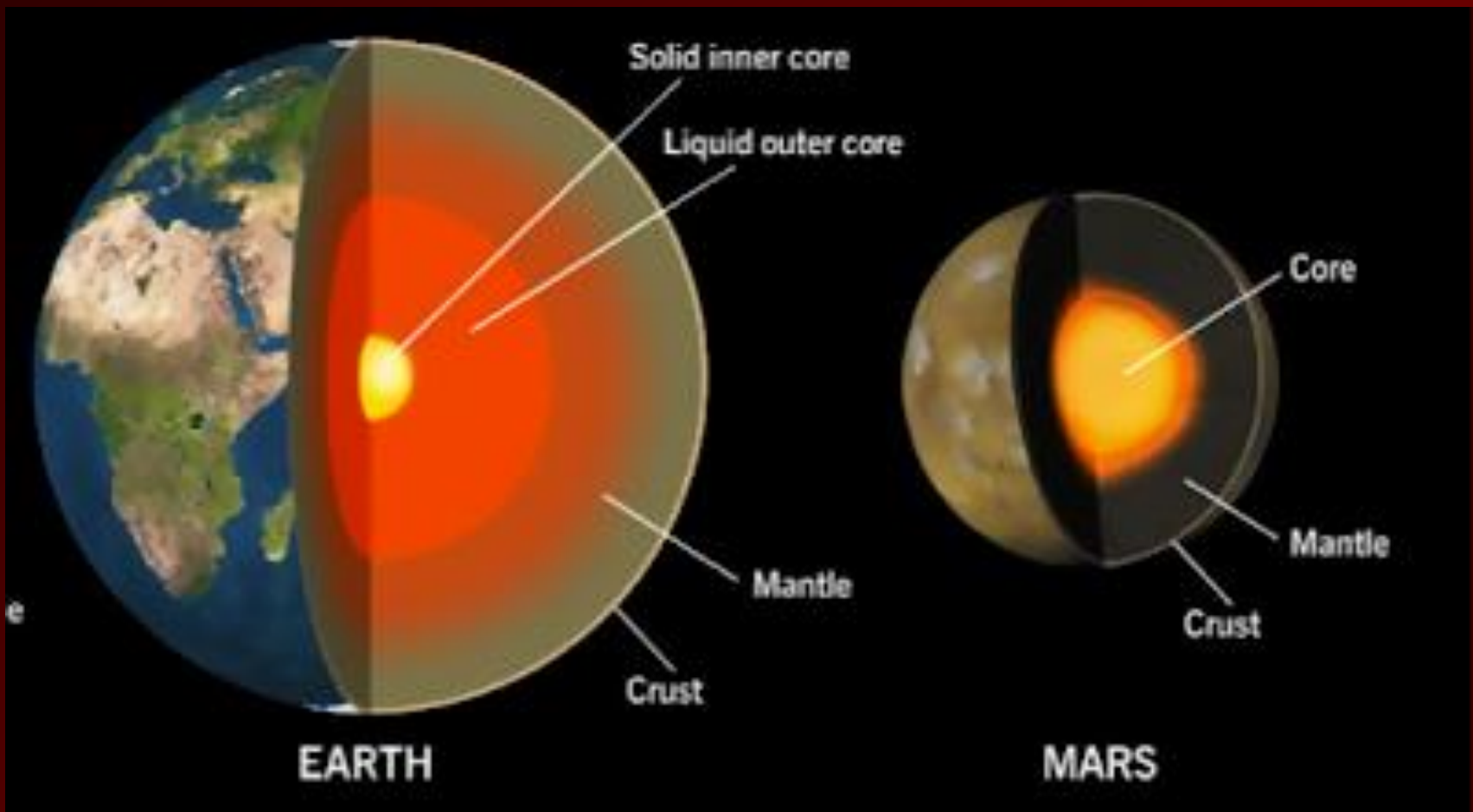
Mars Ice Hypothesis



Devon Island, Mars on Earth



Planetary Structure



Resource Limitations

TERRAFORMING THE MARTIAN ATMOSPHERE?



Mars
0.6%

One of the challenges of terraforming Mars is to increase its atmospheric pressure, which is currently less than 1% that of Earth.



The Martian polar caps, minerals, and soil could all provide sources of carbon dioxide and water to thicken the atmosphere.



Unfortunately, processing all sources available on Mars would only increase the pressure to about 7% that of Earth, far short of what is needed.



Clathrates
0.5%



Polar caps
0.6%



Minerals
1.2%



Adsorbed CO₂
4.0%



Combined sources
6.9%



Earth-like
100%

● Area represents % of greenhouse gases required for Earth-like atmosphere

Hazards of a Mars Mission

- Long-term exposure to zero/ $\frac{1}{3}$ G gravity
- Radiation (Solar & Cosmic)
- Landing (~50% historical success rate)
- Low atmospheric pressure/lack of O₂
- Dust: contamination, adhesion & toxicity
- Excursions over treacherous terrain
- Isolation & duration: crew dynamics & sanity