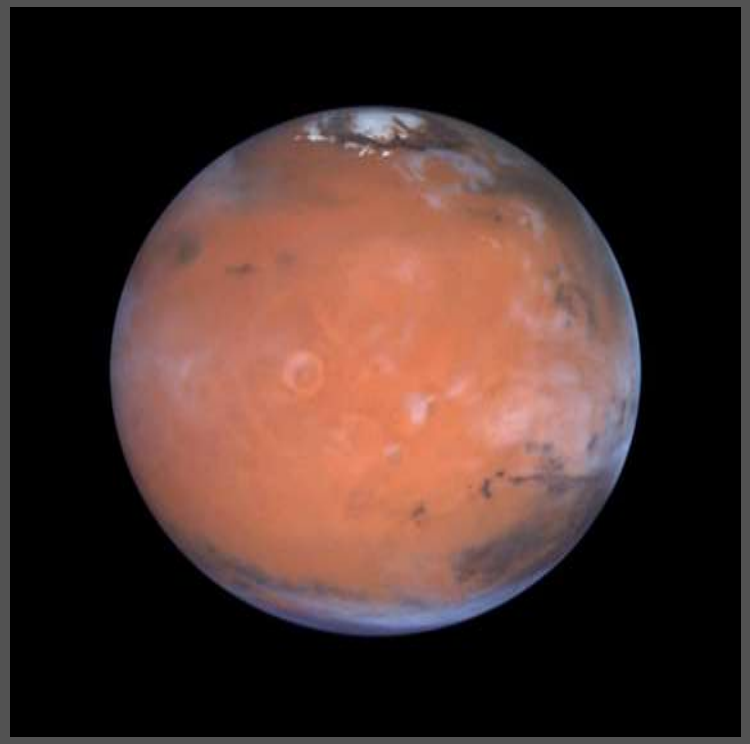
Mars and Meteors



Culpeper Astronomy Club Meeting
July 23, 2018

Overview

- Introductions
- Mars and the Opposition
- Meteor Showers
- Constellations: Scorpius, Draco, Ophiuchus
- Observing Session - Not

Observing Sessions

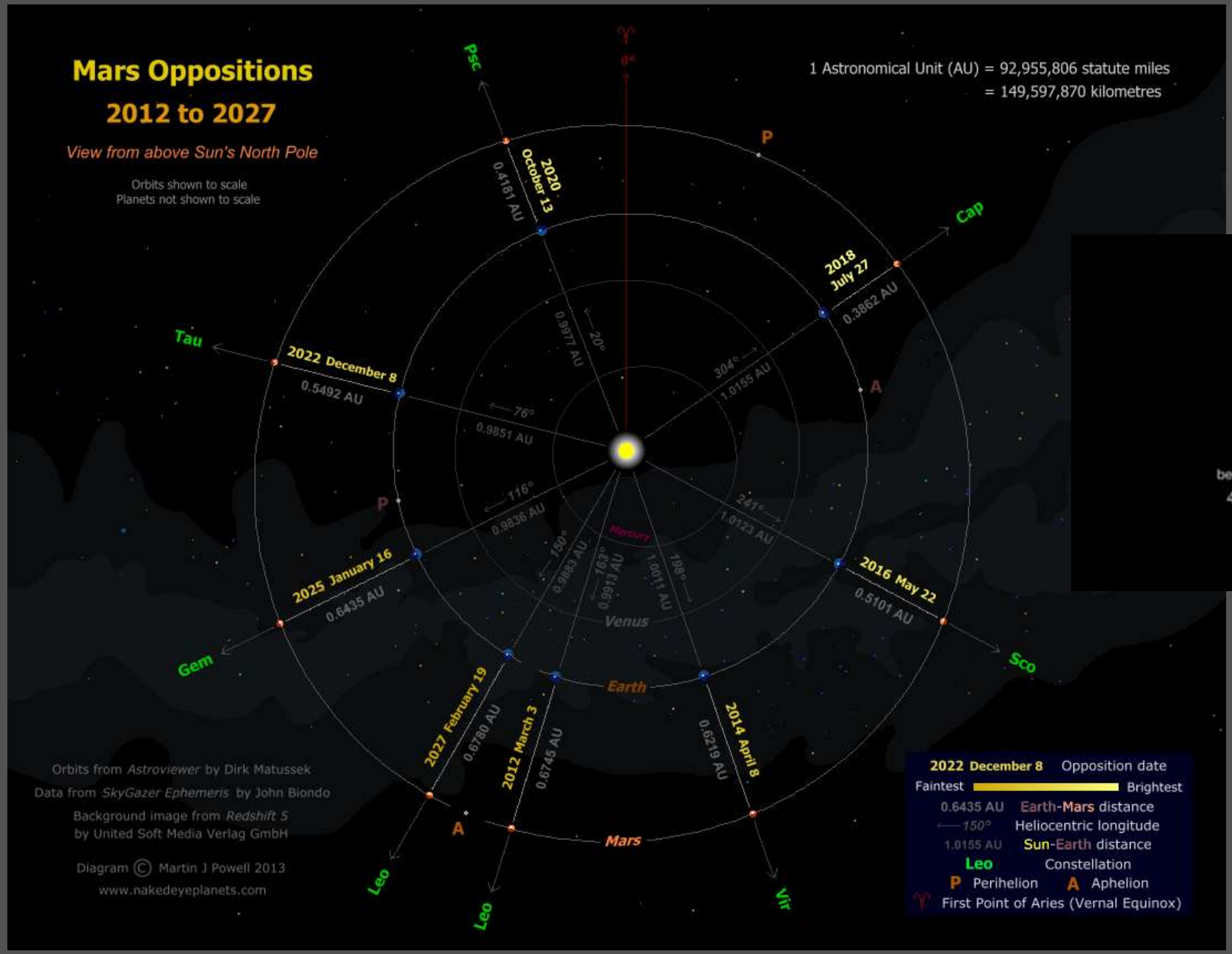
- June 29 Session: 2030 hrs until 0200 hrs
  - Observed all four planets (Venus, Jupiter, Saturn, and Mars)
  - Observed the GRS and the Io/Io Shadow Transit across Jupiter
  - Small number of DSO's and Double Stars

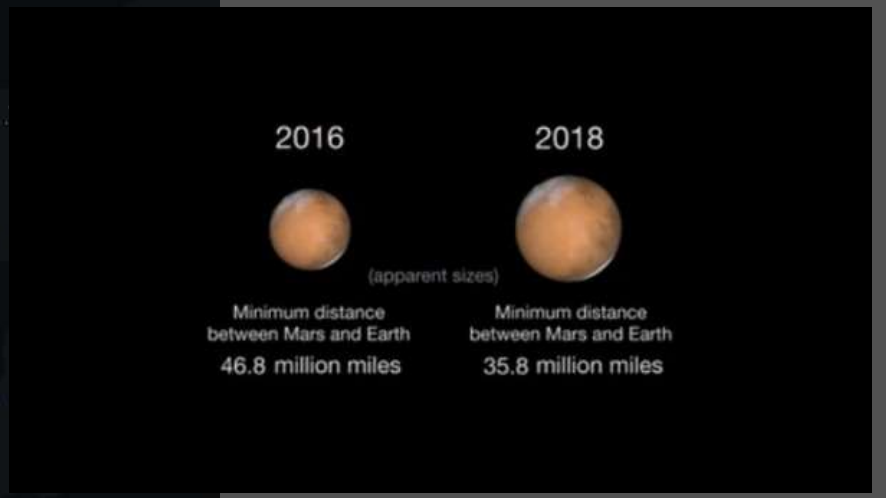
- July 8 Session: 2030 hrs until 0330 hrs
  - Again observed all four planets (Venus, Jupiter, Saturn, and Mars)
  - Observed the Io/Io Shadow Transit across Jupiter
  - Lots of DSO's in Ophiuchus and Sagittarius

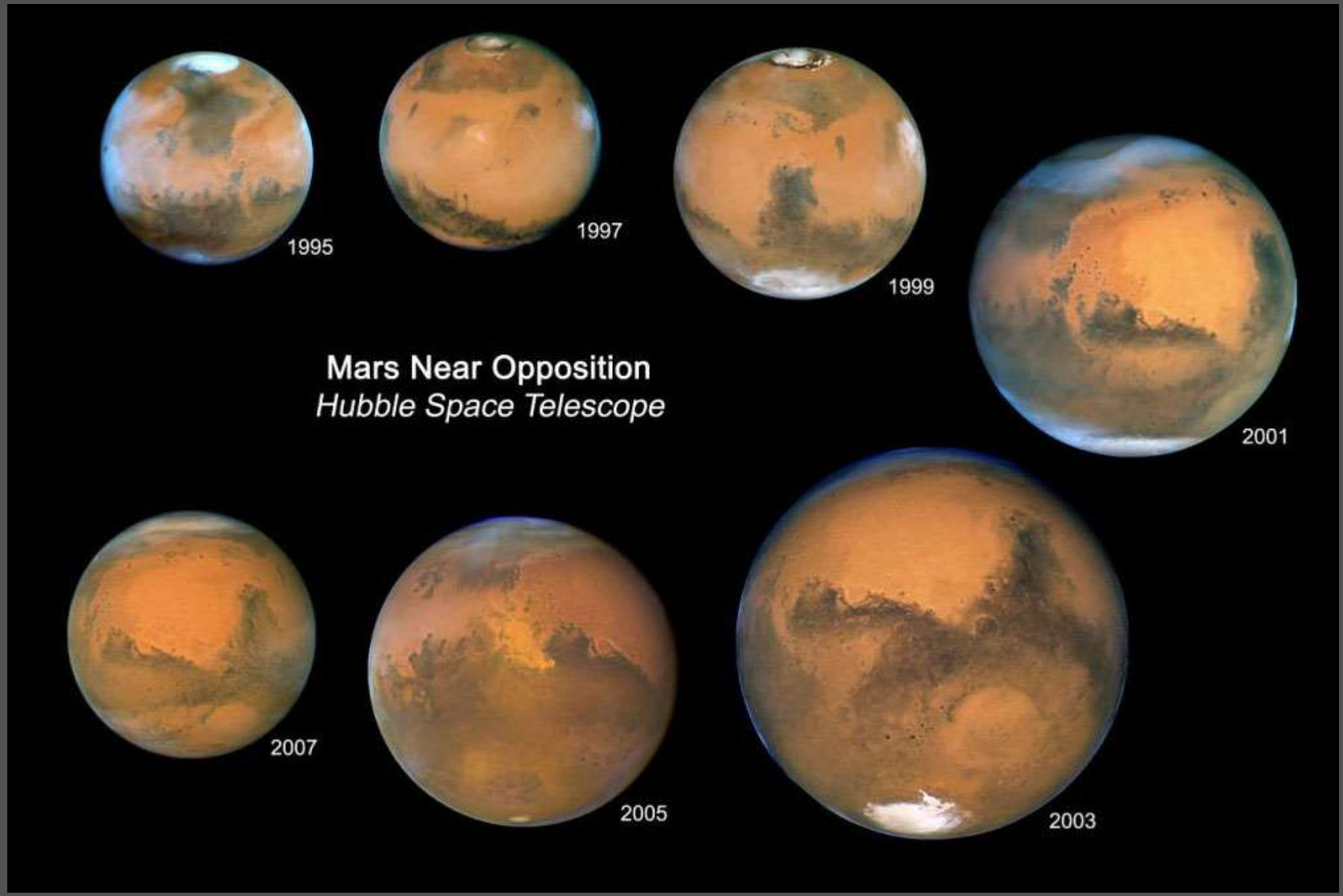
Mars

- The fourth planet from the sun
  - At a distance of about 142 million miles (228 million km)
- Mars is a rocky body about half the size of Earth
  - Has a diameter of about 4200 miles
- Named by the Romans after their god of war
  - Because of its red, bloodlike color
  - Due to the rusty color of its soil, which is comprised of iron-rich minerals
- One day on Mars takes just a little over 24 hours (the time it takes for Mars to rotate or spin once)
- Mars makes a complete orbit around the sun (a year in Martian time) in 687 Earth days

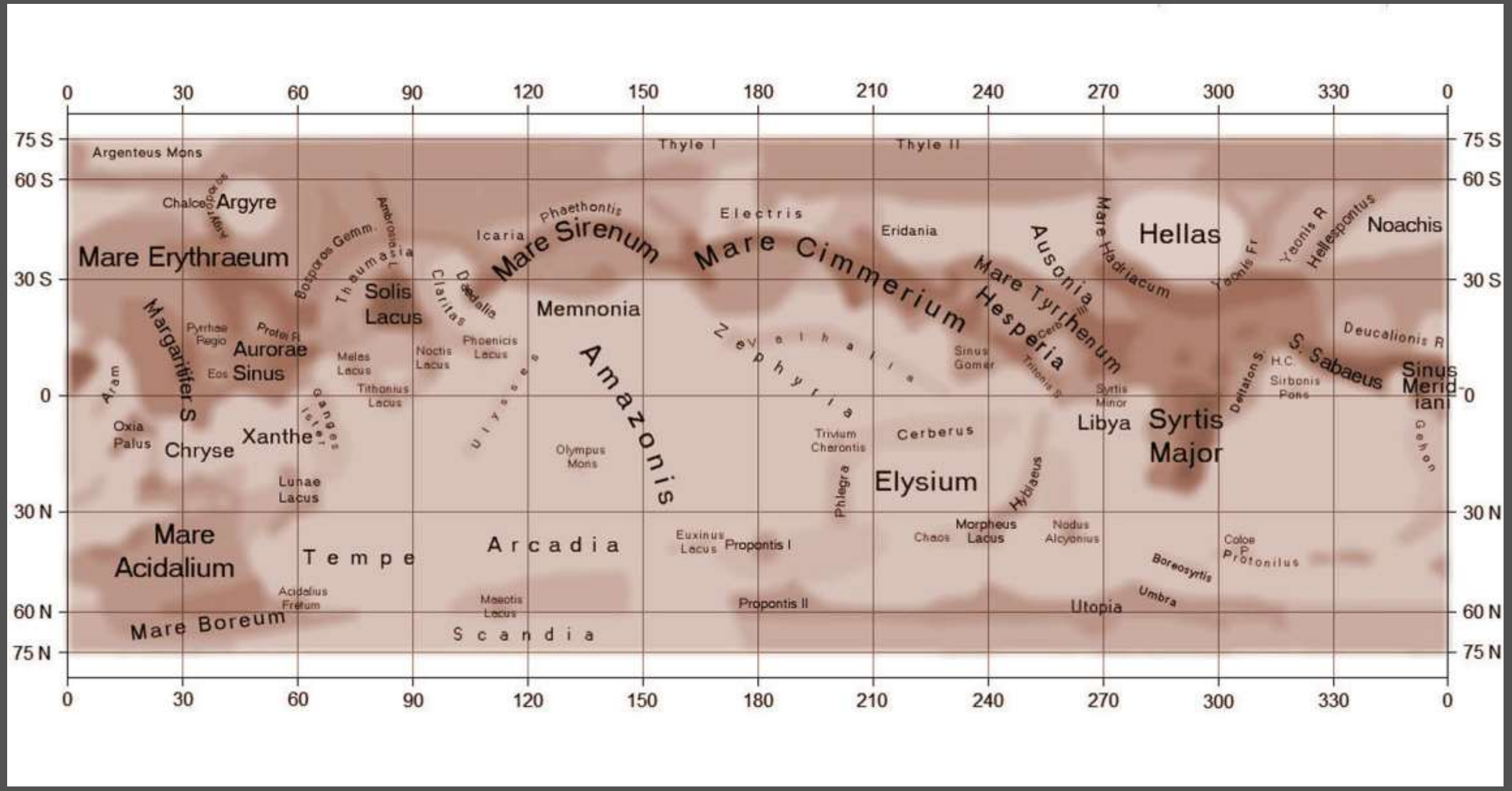
2003 Opposition Hoax


Mars Oppositions
2012 to 2027
View from above Sun's North Pole
Orbits shown to scale
Planets not shown to scale
1 Astronomical Unit (AU) = 92,955,806 statute miles
= 149,597,870 kilometres
Psc
Cap
Tau
Gem
Sco
Leo
Leo
Vir
0°
P
A
2020 October 13
0.4181 AU
2018 July 27
0.3862 AU
2022 December 8
0.5492 AU
2025 January 16
0.6435 AU
2016 May 22
0.5101 AU
2027 February 19
0.6780 AU
2012 March 3
0.6745 AU
2014 April 8
0.6219 AU
0.9977 AU
20°
304°
1.0155 AU
76°
0.9851 AU
116°
0.9836 AU
241°
1.0123 AU
150°
0.9869 AU
163°
0.9913 AU
198°
1.0011 AU
Mercury
Venus
Earth
Mars
Orbits from Astroviewer by Dirk Matussek
Data from SkyGazer Ephemeris by John Biondo
Background image from Redshift 5
by United Soft Media Verlag GmbH
Diagram © Martin J Powell 2013
www.nakedeyeplanets.com
2022 December 8 Opposition date
Faintest Brightest
0.6435 AU Earth-Mars distance
150° Heliocentric longitude
1.0155 AU Sun-Earth distance
Leo Constellation
P Perihelion A Aphelion
First Point of Aries (Vernal Equinox)


2016
2018
(apparent sizes)
Minimum distance between Mars and Earth
46.8 million miles
Minimum distance between Mars and Earth
35.8 million miles

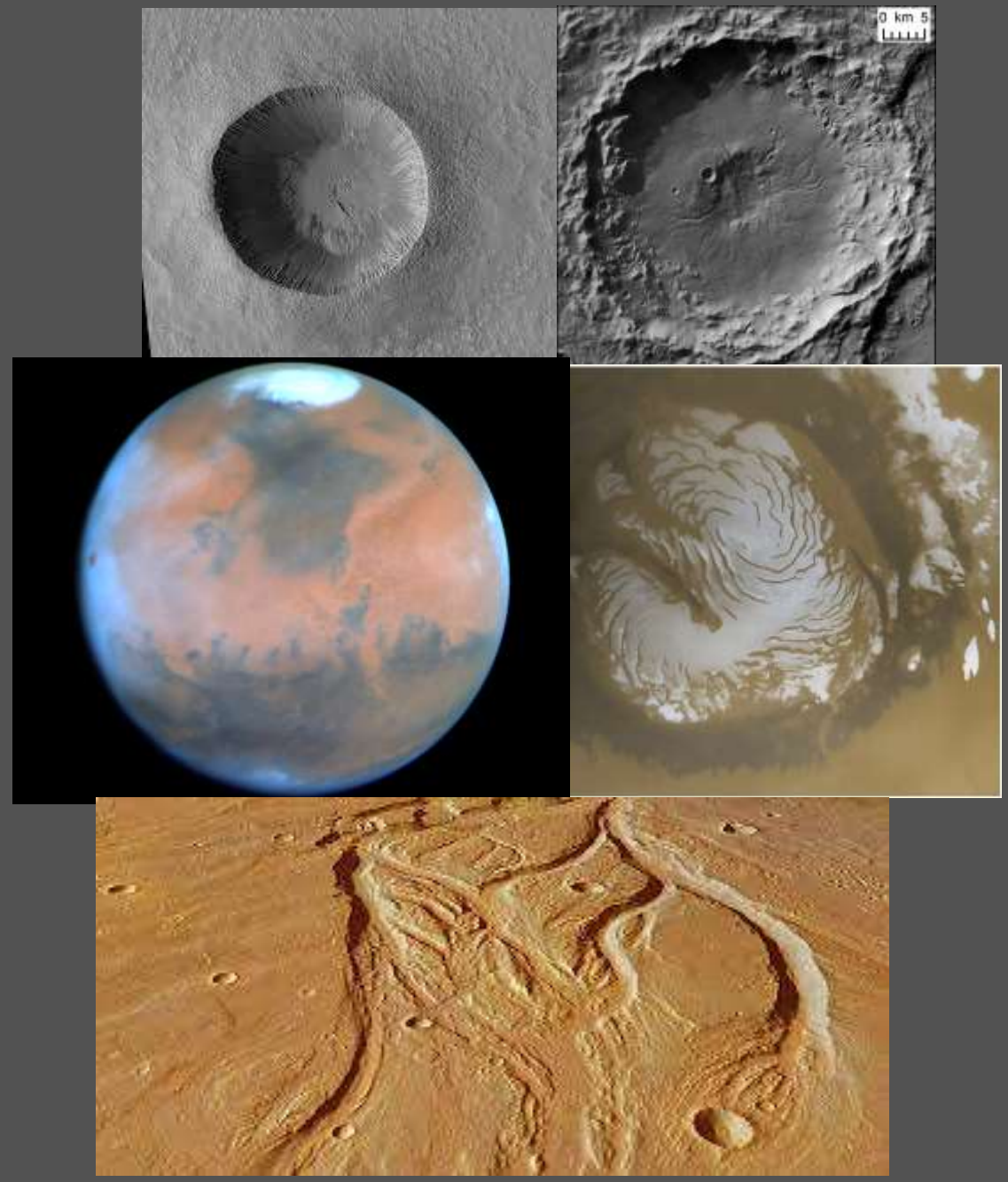

1995
1997
1999
2001
Mars Near Opposition
Hubble Space Telescope
2007
2005
2003

Recent Images


0
30
60
90
120
150
180
210
240
270
300
330
0
75 S
60 S
30 S
0
30 N
60 N
75 N
Argenteus Mons
Thyle I
Thyle II
Chalce
Argyre
Mare Erythraeum
Icaria
Phaethontis
Mare Sirenum
Electris
Eridania
Mare Cimmerium
Ausonia
Mare Hadriacum
Hellas
Noachis
Hellespontus
Yaonis R
Yaonis Fr
Bosporos Gemm
Thaumasia
Solis Lacus
Claritas
Daedalia
Memnonia
Mare Tyrrhenum
Hesperia
Margaritifer S
Pyrrhae Regio
Protei R
Aurorae Sinus
Eos
Aram
Meles Lacus
Noctis Lacus
Phoenicis Lacus
Tithonius Lacus
Zephyria
Sinus Gomer
Cerb
Deucalionis R
S. Sabaeus
Sinus Meridiani
Deltoton S.
H.C.
Sirbonis Pons
Syrtis Minor
Libya
Syrtis Major
Oxia Palus
Chryse
Xanthe
Ganges
Ulyxes
Amazonis
Olympus Mons
Trivium Charontis
Cerberus
Phlegra
Elysium
Hybiaeus
Gehon
Lunae Lacus
Mare Acidalium
Tempe
Arcadia
Euxinus Lacus
Propontis I
Chaos
Morpheus Lacus
Nodus Alcyonius
Coloe P.
Protonilus
Boreosyrtis
Umbra
Utopia
Acidalius Fretum
Meotis Lacus
Propontis II
Mare Boreum
Scandia

Surface Features

- Like Earth, Mars has a North and South Pole
  - The south polar permanent cap is much smaller than the one in the north
  - Mars' polar caps are a combination of water ice and frozen carbon dioxide
  - As the Martian seasons change, the carbon dioxide ice vaporizes in summer, revealing the surface, and freezes again in winter
- The surface of Mars is marked with more than 635K impact craters at least 0.6 miles wide
  - Most of these are to the south of the equator. They seem to have been made by meteorites crashing onto the surface
- “River valleys” which don’t resemble terrestrial counterparts
  - Tributaries are very short, about 100m long (the length of a football field), as if the running water ran out quickly

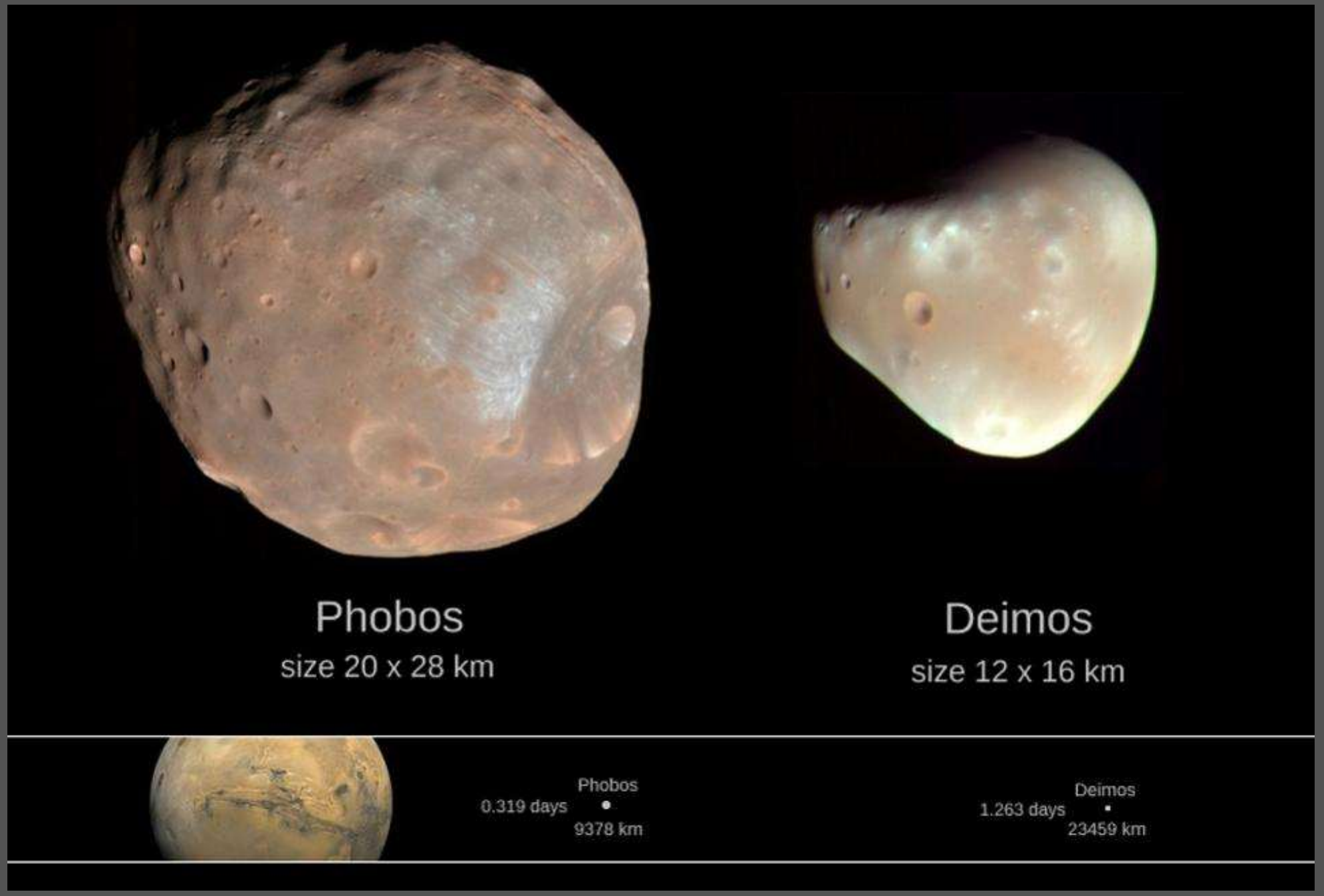


Mars' Moons

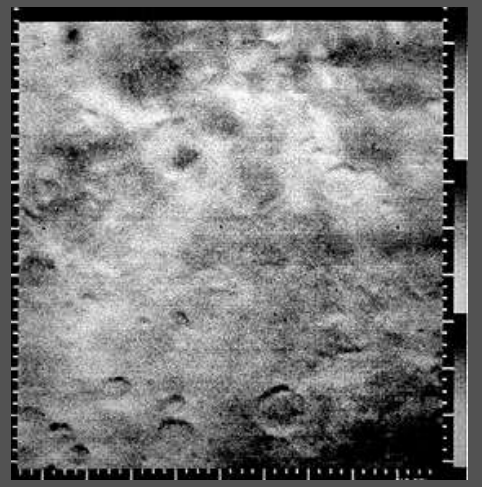
- Mars has two small moons, Phobos and Deimos
  - Phobos, is only 14 miles across (22 kilometers), while the smaller, Deimos, is only 8 miles (13 km), making them some of the smallest moons in the solar system
  - Potato-shaped; too little mass for gravity to make them spherical

- Phobos, the innermost moon, is heavily cratered, with deep grooves on its surface
  - A bit larger than Deimos, and orbits only 3,700 miles above the Martian surface
  - Orbits Mars three times a day
  - Is gradually spiraling inward, drawing about 1.8M closer to the planet each century

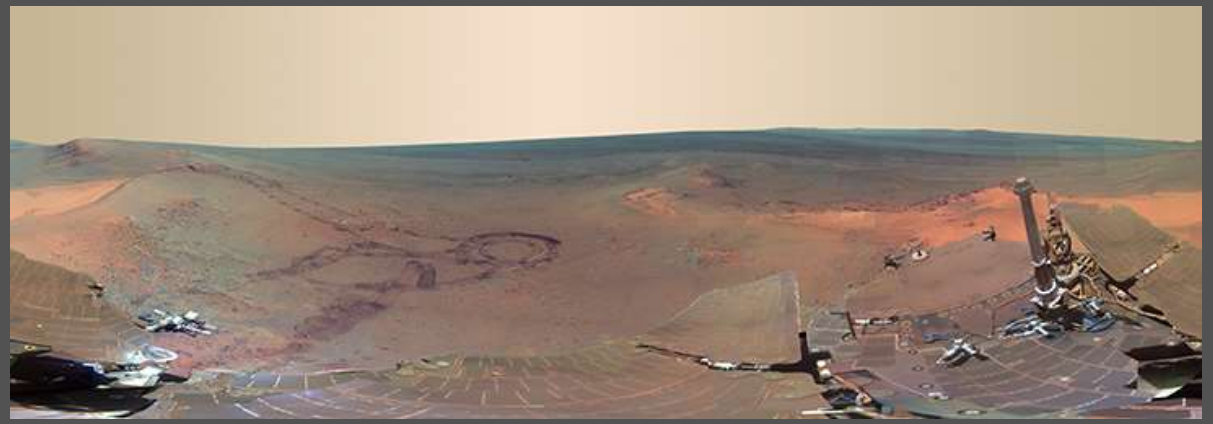
- Deimos has a smooth surface due to a blanket of fragmental rock, except for the most recent impact craters
  - Takes 30 hours for each orbit


Phobos
size 20 x 28 km
Deimos
size 12 x 16 km
Phobos
0.319 days
9378 km
Deimos
1.263 days
23459 km

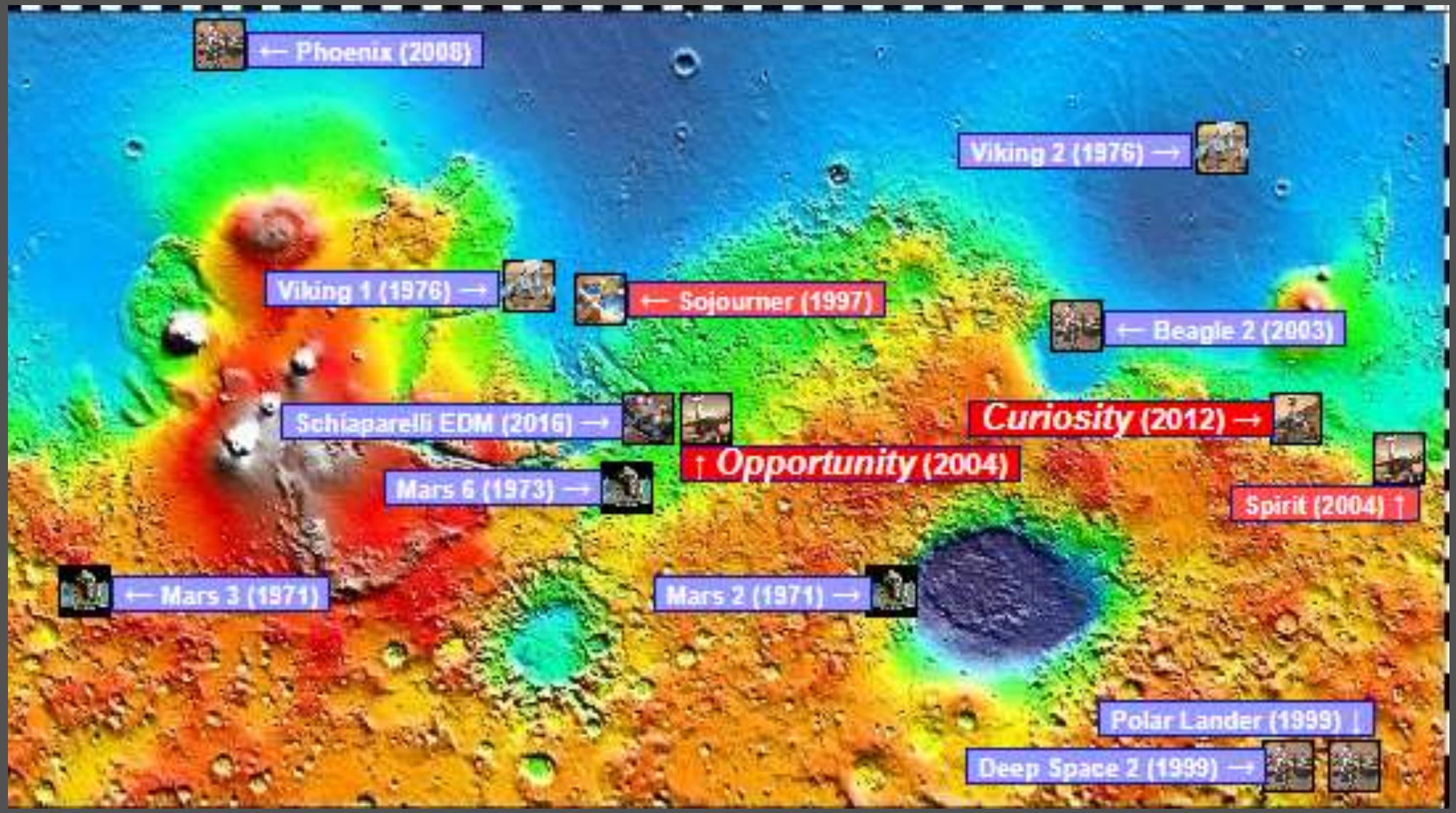
US Missions to Mars



- 1965: NASA's Mariner 4 sends world's first close-up photos
- 1976: Viking 1 and 2 land on the surface of Mars
- 1997: Mars Pathfinder lands and dispatches Sojourner
- 2002: Mars Odyssey begins to make global observations
- 2004: Spirit and Opportunity find strong evidence of long-term liquid water
- 2006: Mars Reconnaissance Orbiter begins returning high-resolution images as it studies the history of water on Mars and seasonal changes.
- 2008: Phoenix finds signs of possible habitability (occasional liquid water and potentially favorable soil chemistry)
- 2012: NASA's Curiosity lands in Gale Crater and finds conditions once suited for ancient microbial life on Mars
- 2018: Insight enroute



Landers and Rovers



Meteors

- Most meteoric material comes from comets spreading debris
- Smaller pieces of rock and iron that travel through space are called Meteoroids
- When debris enters a Earth's atmosphere, it becomes a Meteor
  - Heats up and makes the air around it glow; we see the resulting streak of light
  - Up to 10,000 tons of meteors fall each day; most are the size of a speck of dust
- A meteor that makes it to ground is called a Meteorite
  - Can range in size from tiny pebbles to boulders
  - Largest uncovered…Hoba Meteor…60 tons

Namibia, 1920

Meteors

- Most meteors become visible at around 60 miles up
- On average, meteors can speed through the atmosphere at about 30,000 mph and reach temperatures of about 3,000 degrees Fahrenheit
- Whether an object breaks apart depends on its composition, speed and angle of entry
  - A faster meteor at an oblique angle suffers greater stress
  - Meteors made of iron withstand the stress better than those of stone
  - Even an iron meteor will usually break up as the atmosphere becomes denser, around 5 to 7 miles up
- Some large meteors splatter, causing a brighter flash, which can often be seen during the day and heard up to 30 miles

Meteors

- Sporadic Meteors appear just about every night
- Typical Meteor, Mag 1 to 4, is a brief streak lasting only a second or two
- A bright Meteor, Mag -1 will travel over a longer path and be visible for 2-3 seconds
  - Could leave an ionized trail that glows after the Meteor has burned up and faded
- Any Meteor brighter than Mag -4, the brightness of Venus, is called a Fireball

Barringer Meteor Crater, Arizona

- About 50,000 years ago, a meteorite traveling about 8-12 miles/sec smashed into the Arizona desert
- It was made of nickel-iron and is estimated to have been about 150 ft across, weighing about 300K tons
- Most of the meteorite vaporized on impact; largest fragment weighed about 1500 lbs
- The crater is about 4000 ft wide and 570 ft deep

Chelyabinsk, Russia Meteor

- A similar event occurred over Chelyabinsk, Russia on Feb 15, 2013
- A 65 foot diameter fragment of a near earth asteroid exploded at about 15 miles altitude
- First meteor known to cause injuries
  - More than 1,000 people due to secondary causes
- Largest fragment recovered weighed about 1400 lbs

Meteorites on other solar system bodies

- Mars Rover Opportunity found first meteorite of any type on another planet when it discovered an iron-nickel meteorite about the size of a basketball on Mars in 2005
  - Found larger and heavier iron-nickel meteorite in 2009 in the same region
  - Discovered six meteorites during its travels
- Jupiter and its moons
  - Comet Shoemaker–Levy 9 broke apart in July 1992; collided with Jupiter in July 1994
  - 13 crater chains on Callisto; 3 on Ganymede

Meteor Showers

- **Meteor Showers** result from an interaction between a planet, such as Earth, and streams of debris from a comet
- Comets can produce debris by water vapor drag and by breakup
  - Envisioned as "dirty snowballs," made up of rock embedded in ice, orbiting the Sun
  - The "ice" may be water, methane, or ammonia, alone or in combination
  - The "rock" may vary in size from that of dust to that of a small boulder
- Each time a comet swings by the Sun in its orbit, some of its ice vaporizes and a certain amount of **Meteoroids** result
- The meteoroids spread out along the entire orbit of the comet to form a Meteoroid stream, also known as a "dust trail" (as opposed to a comet's "dust tail" caused by the very small particles that are quickly blown away by solar radiation pressure).

Meteor Showers

- Some of the best are listed below along with dates when the most meteors are visible
  - Quadrantids, January 3-4 (Comet 2003 EH1)
  - Lyrids, April 22-23 (Comet Thatcher)
  - Perseids, August 12-13 (Comet Swift-Tuttle)
  - Orionids, October 20-21 (Halley's Comet)
  - Leonids, November 17-18 (Comet Tempel-Tuttle)
  - Geminids, December 13-14 (Asteroid 3200 Phaethon)
  - Ursids, December 23-24 (Comet 8P/Tuttle)
- The name of each shower refers to the constellation to which the meteors trace their apparent paths

Meteor Showers

- Perseids: Well worth keeping awake for; warmest weather meteor shower. It is not as active as the Leonids, but it is the most widely watched meteor shower of the year, peaking on Aug. 12 with more than 60 meteors per minute

- Orionids: Happens every October and can last for a week, treating patient observers to a show of 50 to 70 shooting stars per hour at its peak

- Leonids: Brightest and most impressive meteor shower; the term “meteor shower” was coined after astronomers' observed one of Leonids' most impressive displays in 1833. The Leonids’ most beautiful display happens at intervals of about 33 years, with the last one occurring in 2002; it is not expected to be repeated until 2028

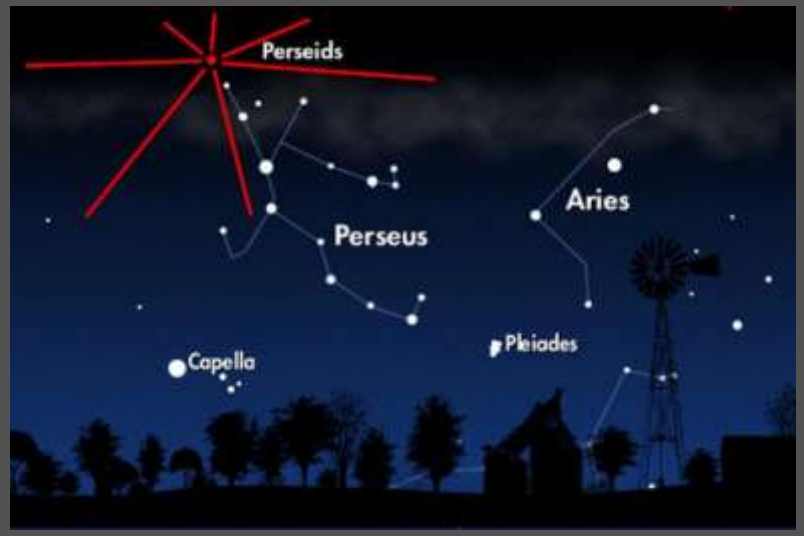
- Geminids: Like the Quadrantids, the Geminid meteor shower came from dust particles of an asteroid, this time a near-earth asteroid called 3200 Phaeton; the Geminids spray up to 40 meteors per hour out of the Gemini constellation at its peak

Tips for Observing

- A dark, clear sky
  - Light pollution or significant moonlight reduces the number of meteors you see
  - Give your eyes at least 15 minutes to adjust to the dark
- Most meteor showers are best viewed in the pre-dawn hours
  - When the part of Earth you are standing on is facing the direction of Earth’s orbit
  - It’s like bugs hitting a car's windshield
- A way to stay comfortable
  - Make yourself comfortable with a reclining lawn chair, sleeping bag, snacks, music, the company of other stargazers
  - Whatever will help you remain interested enough to keep your eyes turned toward the sky
- Sometimes a little like watching the grass grow….be patient

Meteor Showers

Principal nighttime meteor showers					
shower	average date of maximum	normal duration (days)	visual strength (Northern Hemisphere)	entry velocity (km/sec)	associated comet
Quadrantid	January 3	1	medium	41	not known
Lyrid	April 22	1	irregular	48	Thatcher
Eta Aquarid	May 3	5	weak	66	Halley
Southern Delta Aquarid	July 29	8	medium	41	not known
Capricornid	July 30	3	medium	23	not known
Perseid	August 12	5	strong	59	Swift-Tuttle
Andromedid	October 3	11	weak	21	Biela
Draconid	October 9	1	irregular	20	Giacobini-Zinner
Orionid	October 21	2	medium	66	Halley
Taurid	November 8	30	weak	28	Encke
Leonid	November 17	less than 1	irregular	71	Tempel-Tuttle
Geminid	December 14	4	strong	34	(3200) Phaethon*
*This body was classified as an asteroid on discovery, but it is now suspected to be a burnt-out comet. Source: Data derived primarily from A.F. Cook in *NASA SP - 319* (1973).					

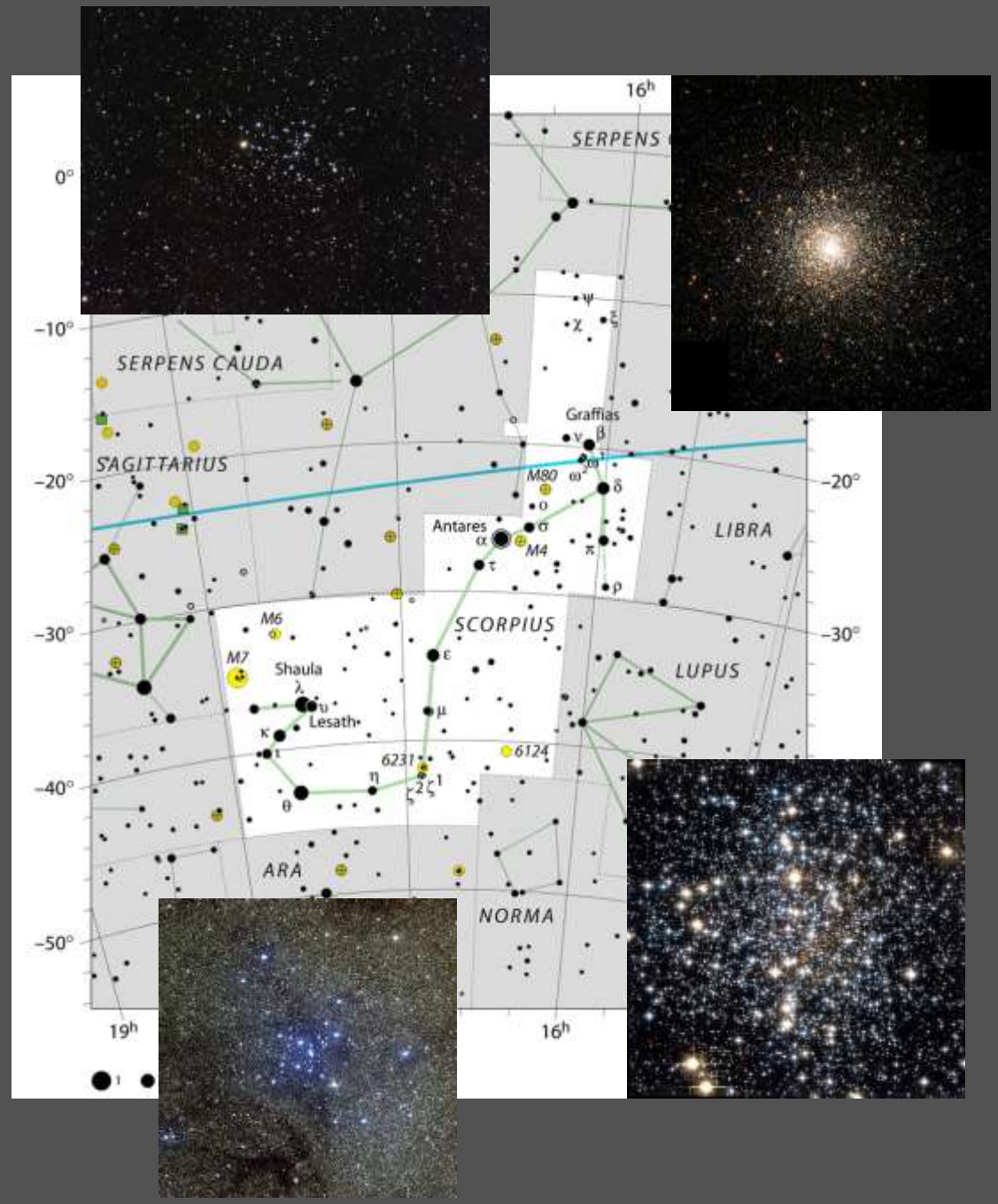


Scorpius- “The Scorpion”

- In Greek mythology, the constellation Scorpius was identified with the scorpion that killed Orion, the mythical hunter

- Beta Scorpii is a binary star separated by 13.5 arc sec
  - Primary is binary star with an orbital period of 610 years and its own brighter component is a spectroscopic binary, with components separated by only 1.42 miliarcsec and orbiting each other every 6.82 days
- Pi Scorpii is a triple star system with a combined visual magnitude of 2.9; 590 light years distant

- Deep Sky Objects include:
  - Two Clusters (M6 and M7), and two Globular Cluster (M4, and M80)



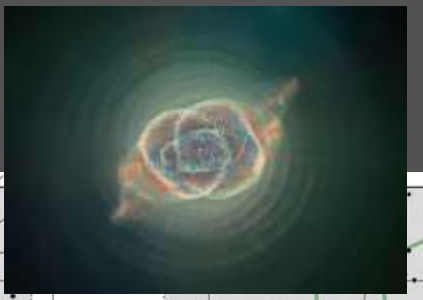
Draco – “The Dragon”

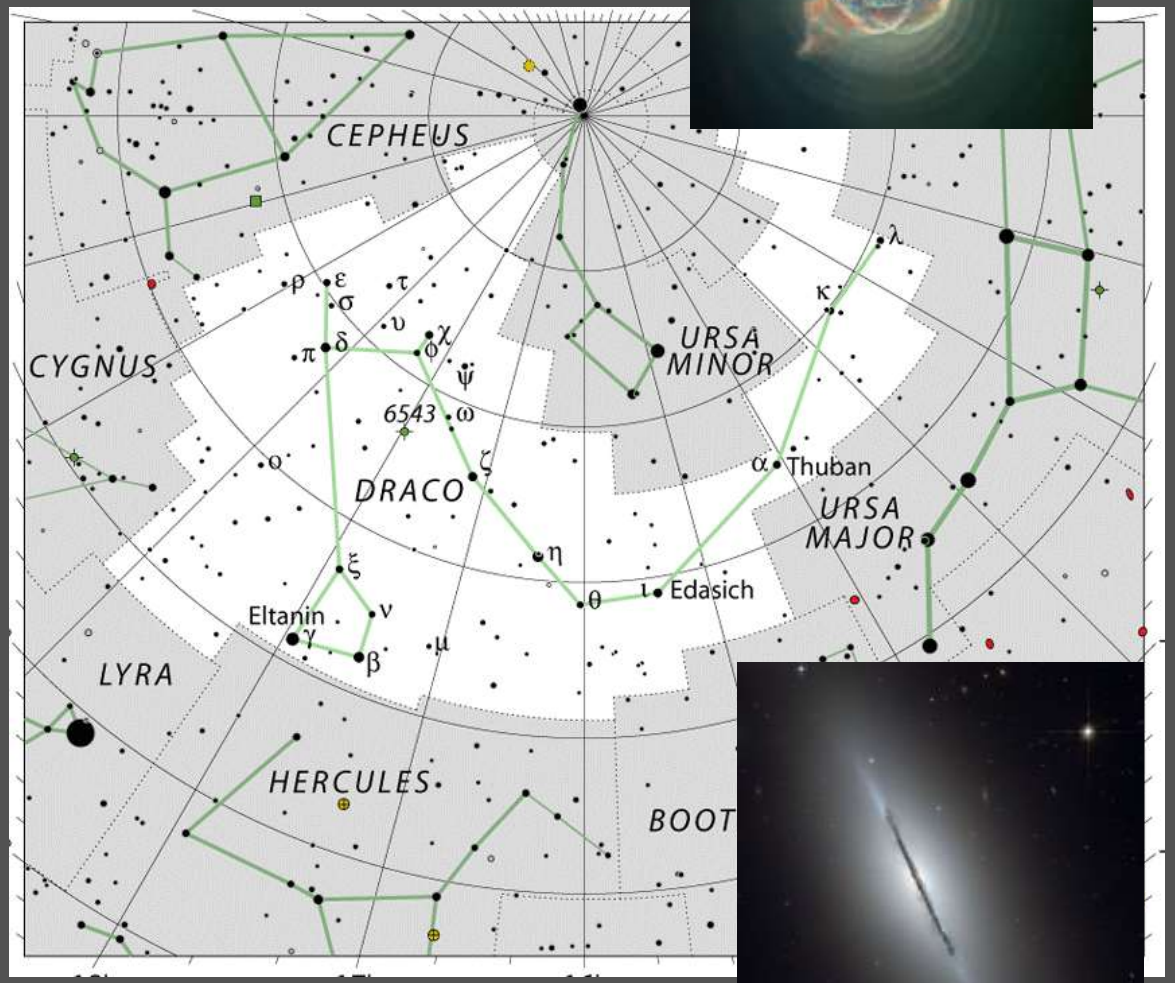
- Draco represents Ladon, the dragon that guarded the gardens of the Hesperides in Greek mythology

- Double Stars:
  - Nu Dra: two white stars; 62” sep
  - 39 Dra: Triple star; white-white-blue; 90”, 3.7” sep

- Deep Sky Objects:
  - NGC 6543 (Catseye Nebula): a planetary nebula 3300 light years distant; visual magnitude of 9.8

  - M102 (Spindle Galaxy): a spiral or lenticular galaxy; apparent magnitude of 10.7; 50M light years distant



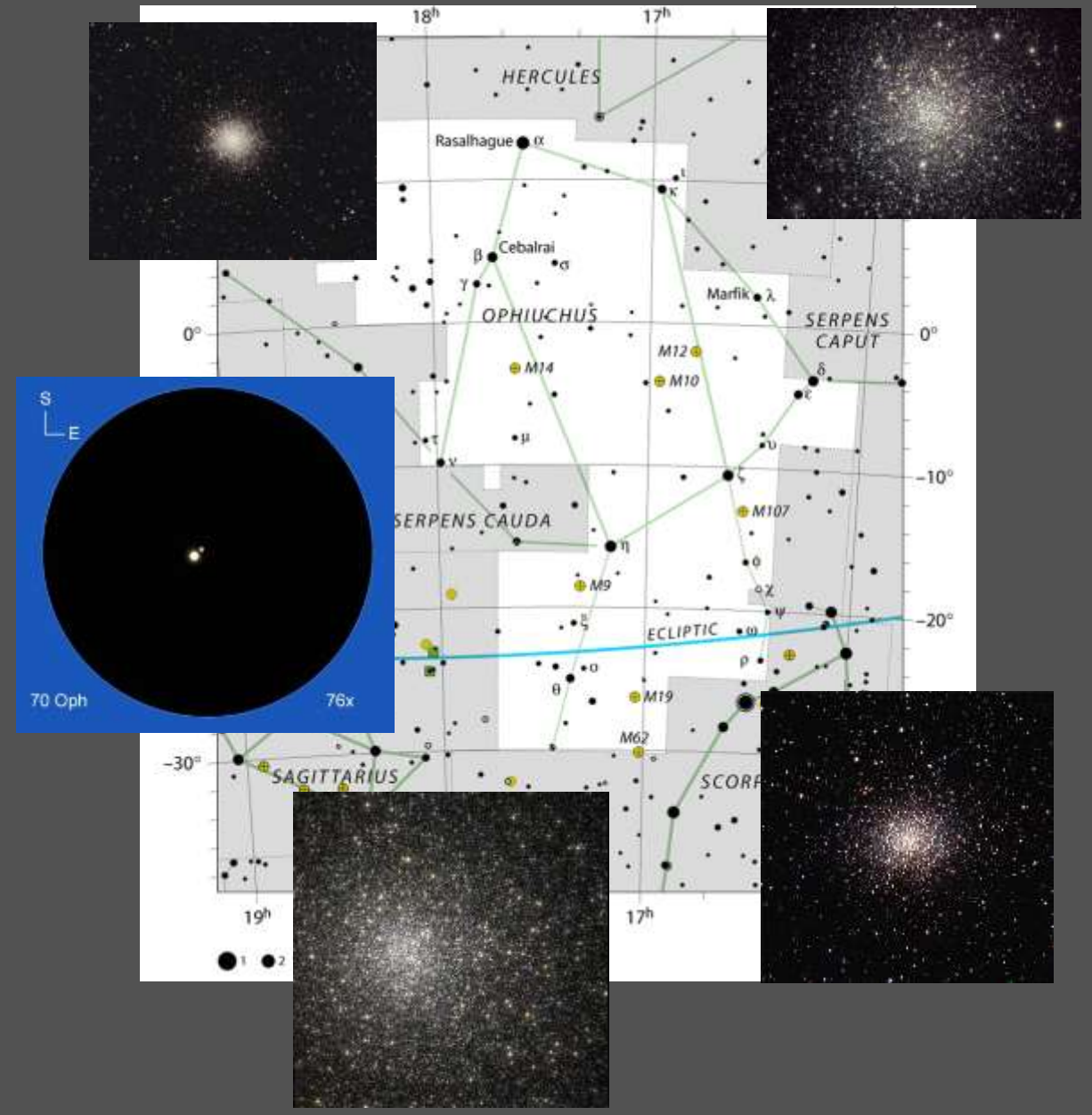


Ophiuchus – “Serpent Bearer”

- Ophiuchus is generally depicted as a man holding a snake, represented by the neighboring constellation Serpens

- Interesting Stars:
  - 70 Ophiuchi (Binary Star, 15LY Distant)
  - Two orange Dwarf Stars

- Ophiuchus contains seven Messier objects:
  - M9, M10, M12, M14, M19, M62, and M107 (All Globular Clusters)
  - Many other NGC globulars



Comet PanSTARRS

Upcoming Events

- Mars Opposition: July 27
- Lunar Eclipse: July 27 (Not North America)
- Perseid Meteor Shower: August 12-13
- Next Meeting: August 27
  - Primary Topic: Variable Stars

Backup Slides

Mars Environment

- Mars is very cold with the average temperature of -80 degrees Fahrenheit
- Mars has clouds and wind just like Earth
  - Sometimes the wind blows the red dust into a dust storm
  - Tiny dust storms can look like tornados and large ones can be seen from Earth
  - Mars' large storms sometimes cover the whole planet
- Mars has about one-third the gravity of Earth
  - A person who weighs 100 pounds on Earth would only weigh about 37 pounds on Mars
- Mars' atmosphere is much thinner than Earth's
  - The atmosphere of Mars contains more than 95 percent carbon dioxide and much less than 1 percent oxygen
  - Earth's (78% nitrogen; 21% oxygen; traces of carbon dioxide)

Mars Moon’s Origins

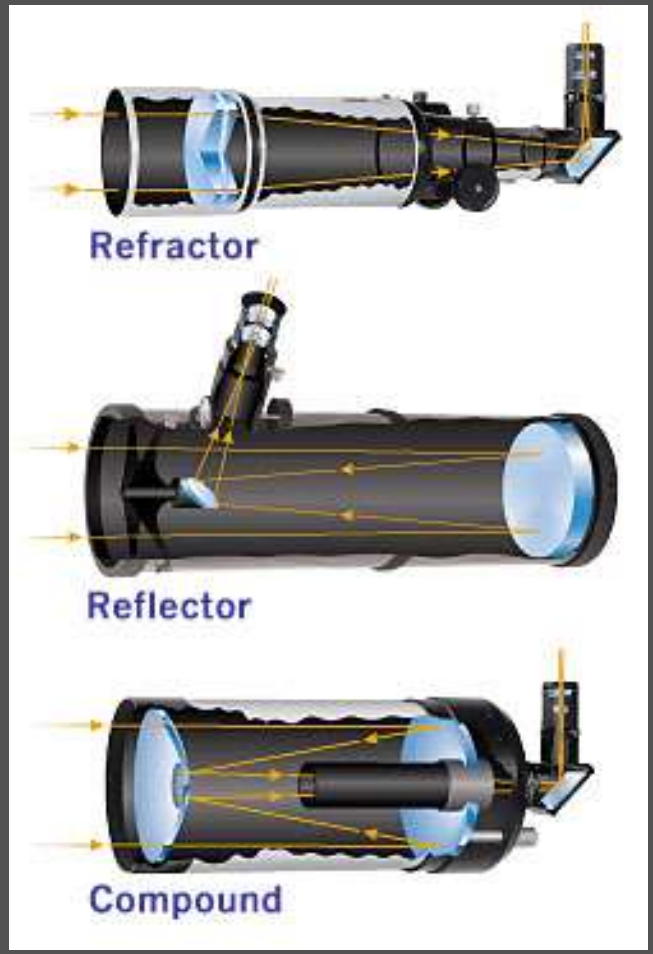
- Because of their odd shapes and strange composition, scientists thought for a long time that both moons were born asteroids
  - Stable, nearly circular orbits of the moons make such a birth appear unlikely
  - Captured bodies tend to move more erratically; Mars atmosphere too thin to have slowed the pair down and settled them into their present-day orbits
- Alt 1: Could have formed from debris left over from the creation of Mars; gravity could have drawn the remaining rocks into the two oddly shaped bodies
- Alt 2: Moons could have spawned from a violent birth, much like Earth's moon
  - A collision, common in the early solar system, could have blown chunks of the red planet into space, and gravity may have pulled them together into the moons
  - Similarly, an early moon of Mars could have been impacted by a large object, leaving Phobos and Deimos as the only remaining bits
- Latest proposal combines the two - a collision once scattered debris into a ring around Mars that “accreted” the young moons

Introducing "*Morning Calm Observatory*"

- Owner: Donovan Brock
- Location: Reva, VA
- Main Scope: 30" Dobsonian
- Secondary Scopes: 20" and 12.5" Dobsonians; several SCT's, Newtonians, and refractors

Three Basic Telescope Types

- Refractors have a lens at the front of the tube — it's the type you're probably most familiar with
  - Generally low maintenance, get expensive as the aperture increases
  - An apochromat offers better optical quality (and is more expensive) than an achromat of the same size
- Reflectors gather light using a mirror at the rear of the main tube
  - For a given aperture, these are generally the least expensive type, but you'll need to adjust the optical alignment every now and then — more often if you bump it around a lot — but that adjustment (called collimation) is straightforward.
- Compound (or catadioptric) telescopes, use a combination of lenses and mirrors, offer compact tubes and relatively light weight
  - Two popular designs are called Schmidt-Cassegrains and Maksutov-Cassegrains



Mounts – Most Important

- Alt-Az: On some mounts the scope swings left and right, up and down, just as it would on a photo tripod; these are known as altitude-azimuth (or simply alt-az) mounts
  - Many reflectors come on a simple wooden platform, known as a Dobsonian; a variation of the alt-az mount
- Equatorial: A more involved mechanism, designed to track the motion of the stars by turning on a single axis
  - Tend to be larger and heavier than alt-az designs
  - To use an equatorial mount properly you'll also need to align it to Polaris, the North Star