Part 1: Observation of Mars

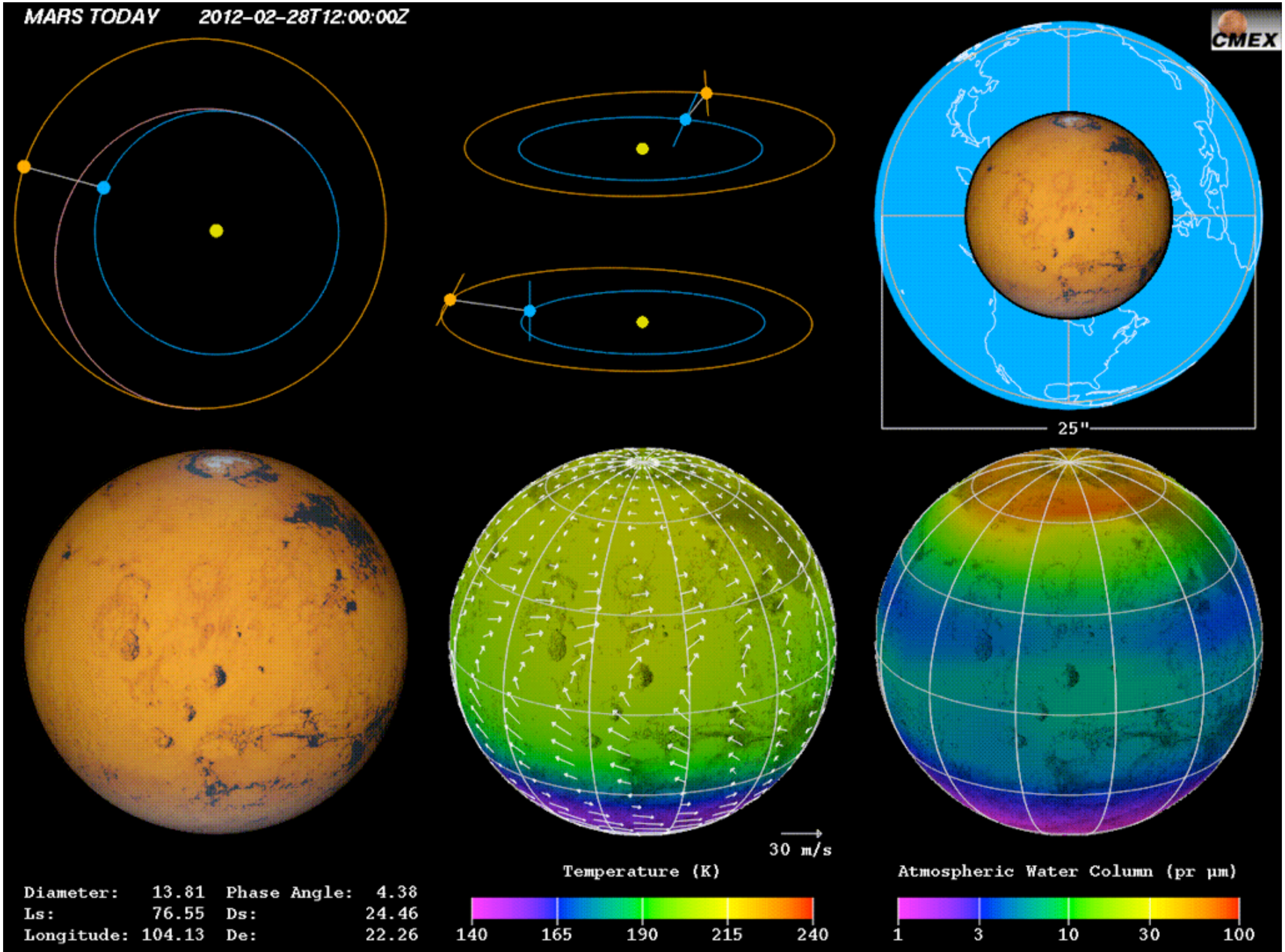
Size of Mars

Mars is too small to see as anything other than a point with the naked eye. Even at its largest, it is too small to resolve as a disk.

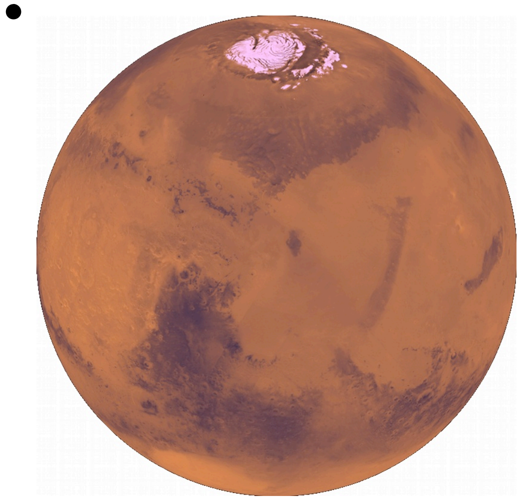
This image shows the full Moon next to an image of Mars scaled to its maximum size (~25.1 arc seconds) and a circle representing the minimum size of an object that can be resolved as a disk (about 36 arc seconds.)

So much for the "Mars Hoax."

Mars Today: http://humbabe.arc.nasa.gov/



Mars Current Conditions:



Northern Hemisphere: Late Summer
Southern Hemisphere: Late Winter

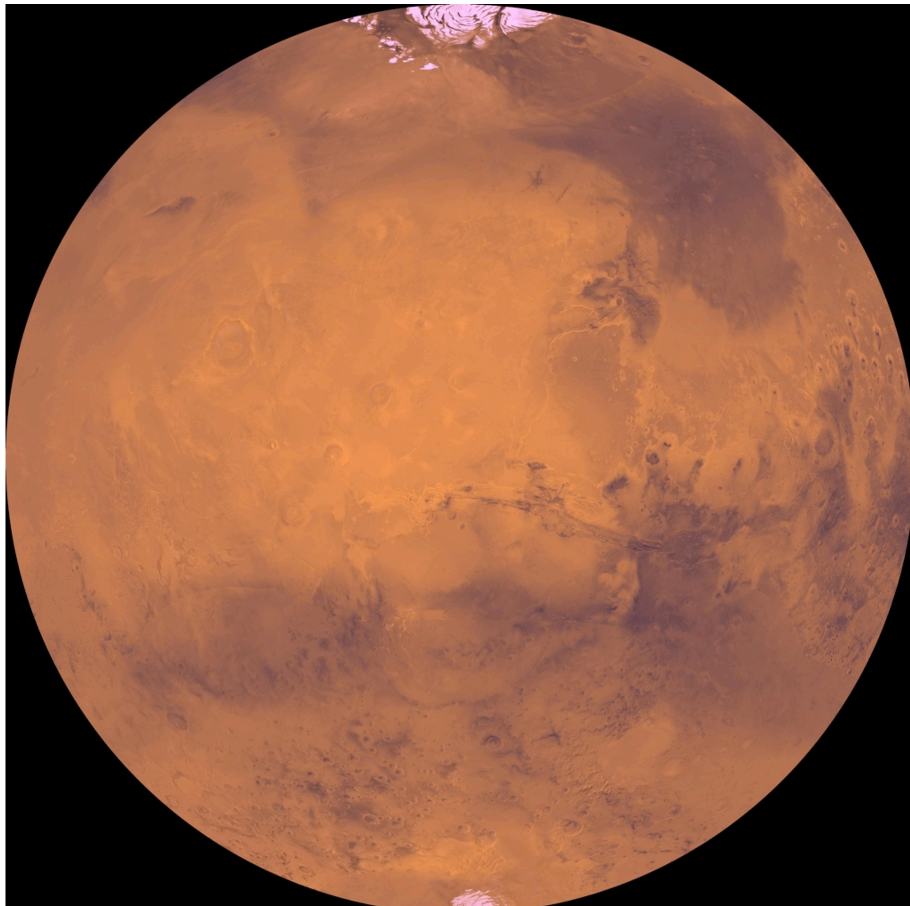
Possible dust storms.
Possible clouds in southern polar region.

Northern polar cap small, at a good viewing angle.
Southern polar cap large, at a poor viewing angle.

Currently up all night:

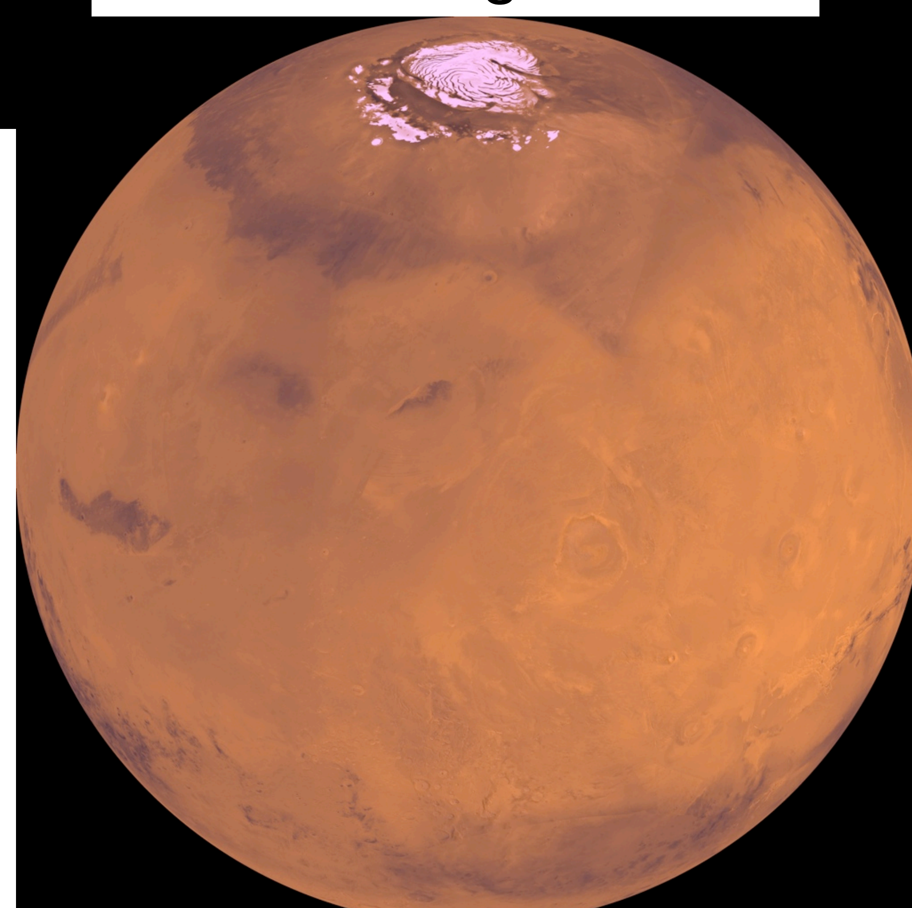
Date (Local)	March 7	March 14	March 30	April 15	May 15	June 15	July 15
Rises	5:23pm	4:48pm	3:23pm	2:10pm	12:41pm	11:41am	11:00am
Transits	Midnight	11:28pm	10:06pm	8:53pm	7:14pm	5:59pm	4:54pm
Sets	6:37am (8th)	6:07am (15th)	4:50am (31st)	3:36am (16th)	1:47am (16th)	12:11am (16th)	10:48pm
Size (arcseconds)	14.0”	14.0”	13.0”	11.0”	8.8”	7.2”	6.1”
Brightness (vis. mag.)	-1.19	-1.08	-0.74	-0.35	0.26	0.70	0.98

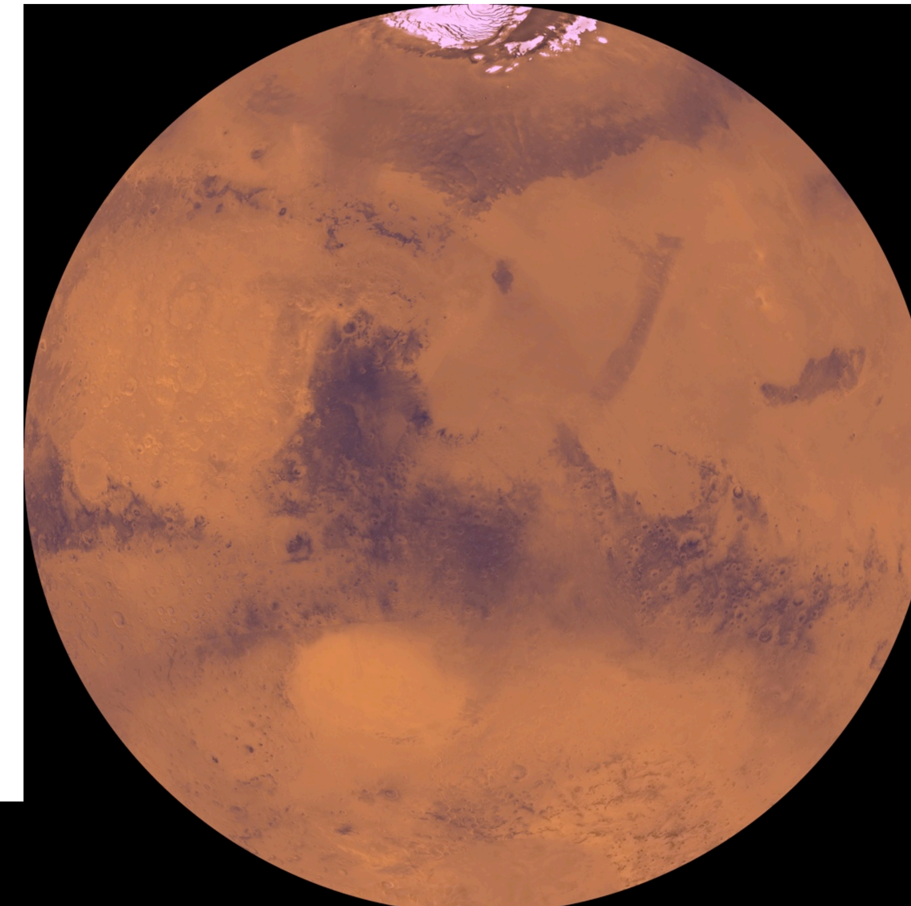
Different Faces of Mars



90° Longitude

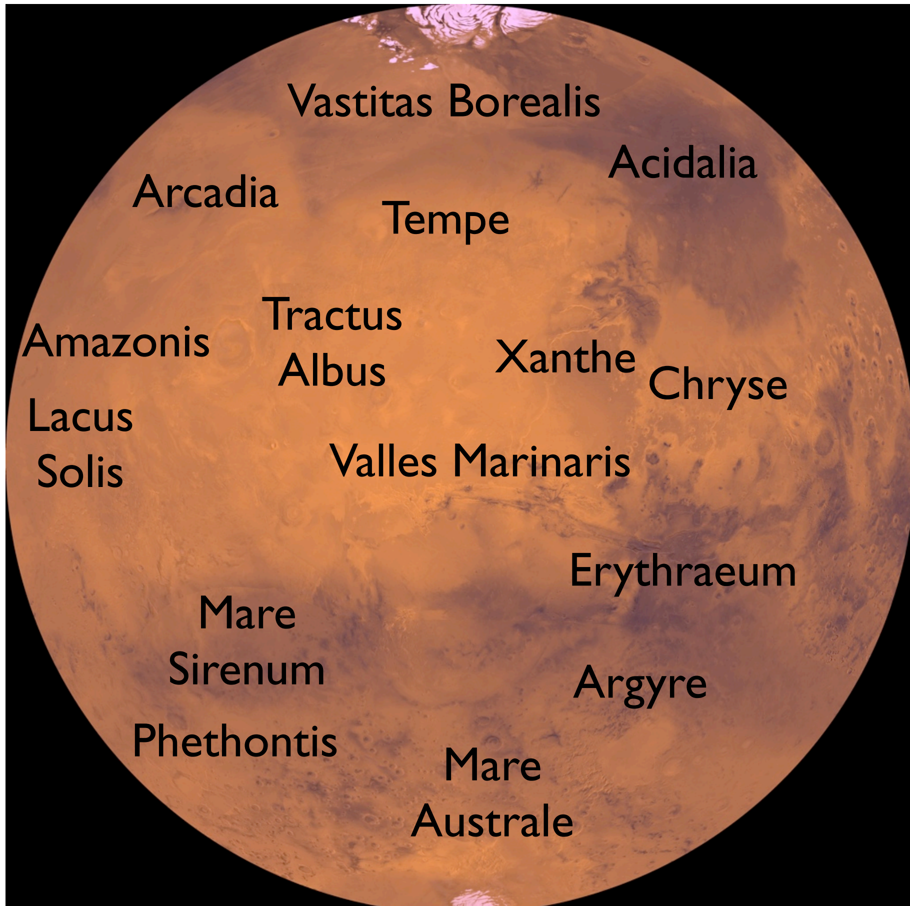
150° Longitude



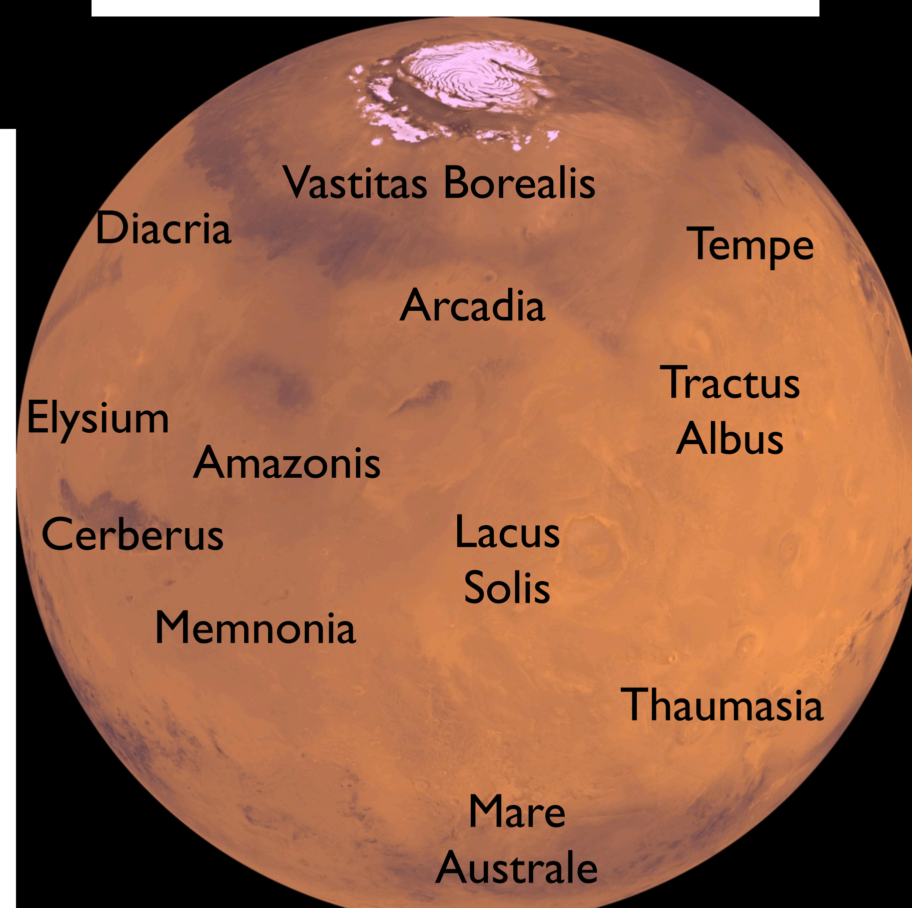


270° Longitude

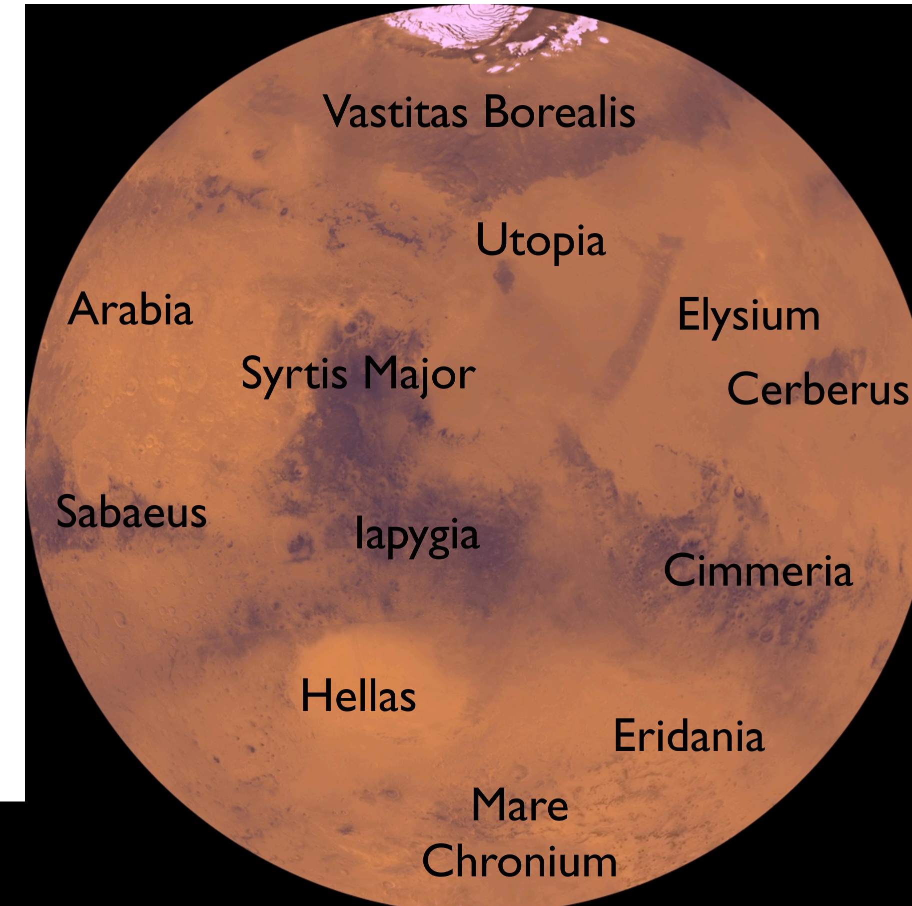
Different Faces of Mars



90° Longitude
0° Latitude

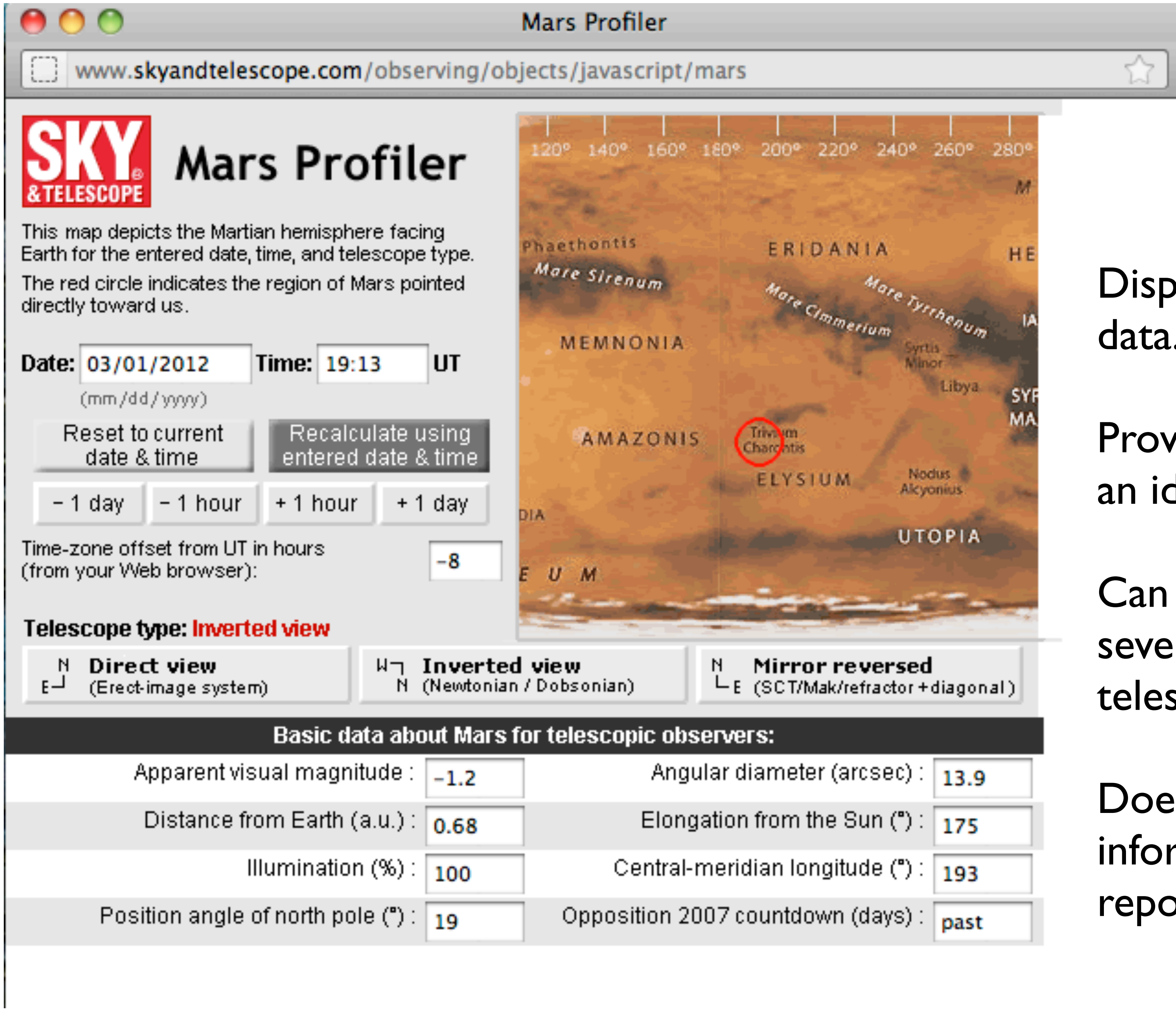


150° Longitude
30° N Latitude



270° Longitude
0° Latitude

S&T Mars Profiler



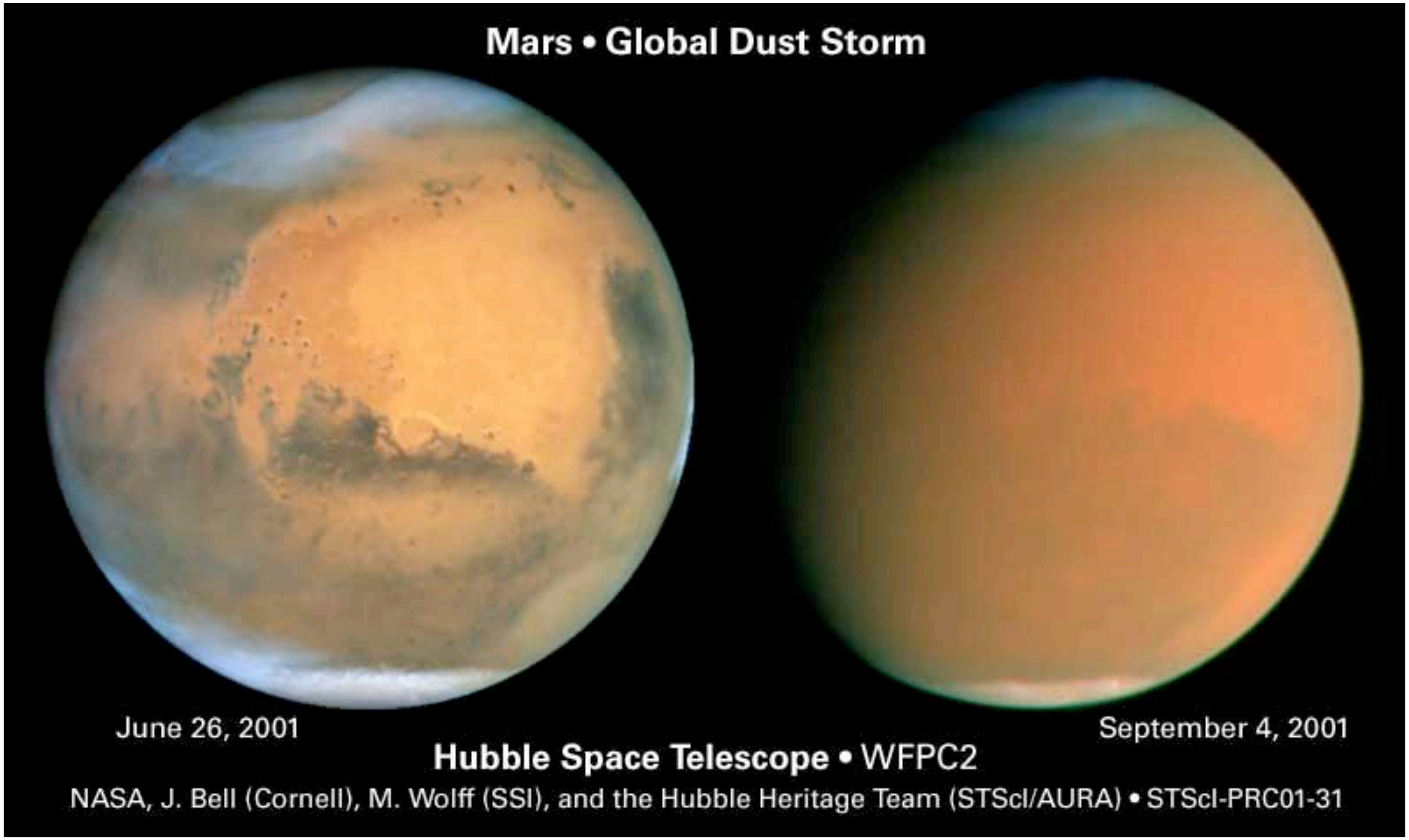
Displays current calculated data.

Provides feature names and an idealized image of Mars.

Can change the image for several different types of telescopic view.

Does not provide weather information or observers' reports.

Mars Weather
Clouds and Dust Storms



Use Blue Filters to Highlight Clouds

Use Red Filters to *Try* to See Detail in Storms

Aperture and Magnification

A clock drive is necessary to keep Mars in the field of view when using high power magnification. This allows the observer to remain still and relax, allowing them to see the most detail.

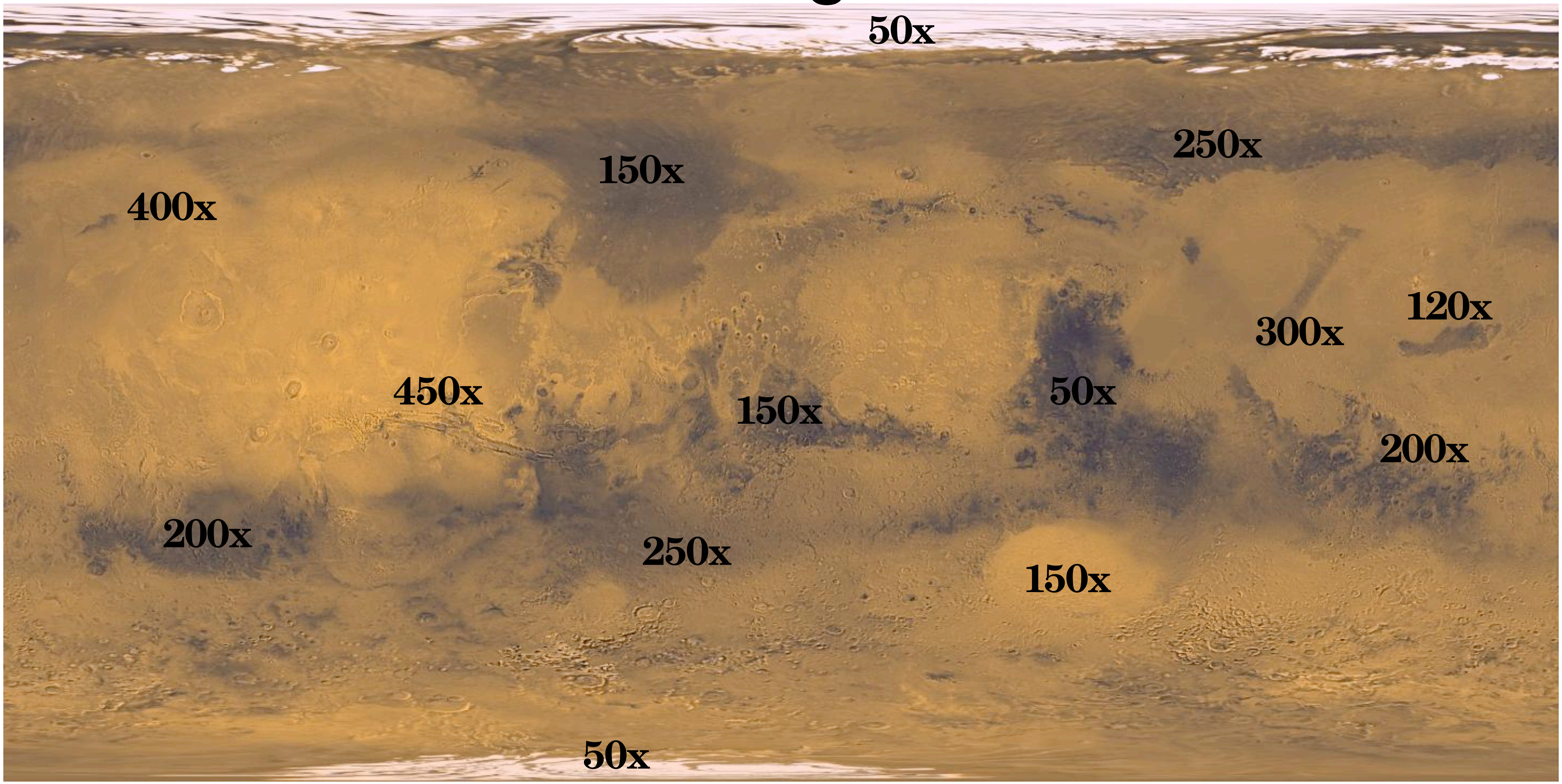
“Slow” focal ratios (over f/6) will generally improve the clarity of the image.

Small or no obstruction in the optical train will greatly improve the image detail.

Larger apertures will reveal more color and more subtlety in color, as well as provide more contrast when using filters. However, detail can be washed out in bright areas, so being able to variably mask off some of the light during observation can bring out more detail to the eye (e.g. the “Hat Trick”.)

Typical Magnification	Unobstructed Aperture	Obstructed Aperture
300x	about 4” or 90-110mm	about 6” or 150mm
400x	about 5”	about 8” or 200mm
450x	about 6”	about 10” or 250mm
500x	about 7”	about 12” or 300mm
600x	>8”	13” or 325mm on up

Minimum Magnifications



Assumes good optics and viewing conditions with Mars near opposition.

These are the minimum magnifications to make out features at all, higher magnifications are required to make out details in these objects.

300-450x are typical magnifications to observe detail in the surface of Mars.

High contrast objects with strong edges (Polar Caps, Syrtis Major) stand out at lowest powers.

Contrast in this image is different from the contrasts seen during visual observation.

Contrast of objects varies by time/location on Mars and local Earth observing conditions.

Using Color Filters on Mars

General:

Red filters bring out the most subtlety of shading.

Yellow brings out the most detail.

Blue brings out the polar caps,clouds,and provides strong surface feature contrast.

Details:

Red (e.g. Wratten 25, 25A, 29)
Show contrast between dusky areas and bright desert areas. Best filter at lower powers for general detail.

Yellow/Orange (e.g. Wratten 15, 21, 23A)
Reduce brightness of reddish areas to bring out fine detail of the surface,good in both bright and dark (sea) areas. Tends to steady the image by suppressing light scattering.

Green (e.g. Wratten 56, 57, 58)
Bring out light spots in the reddish surface areas,dust storms,and edges of polar caps to some degree. The least useful filter color for Mars,requires high magnification and steady viewing to get the advantage of use.

Blue/Violet (e.g. Wratten 38, 38A, 47, 80A)
Bring out polar caps,detail in polar caps,clouds,polar hazes,clouds on limb of Mars.

Observing Phobos and Deimos

Minimum practical aperture for observation ~10” (250mm)

May be observed under optimum conditions in instruments as small as 6” (150mm).

Can routinely be observed in 16” and larger instruments.

Observation requires that Mars be occulted.

Deimos is typically easier to observe as it obtains a greater elongation than Phobos,and is a bit more reflective.

Grayscale level comparison of Phobos (left) and Deimos (right).


Part II:
Exploration of Mars

Exploring Mars is Difficult: 66% Failure Rate

USSR/Russia

21 Attempts
15 Failures
6 Partial Successes
1 Successes

U.K./Europe

3 Attempts
1 Failures
0 Partial Successes
2 Success

U.S.A.

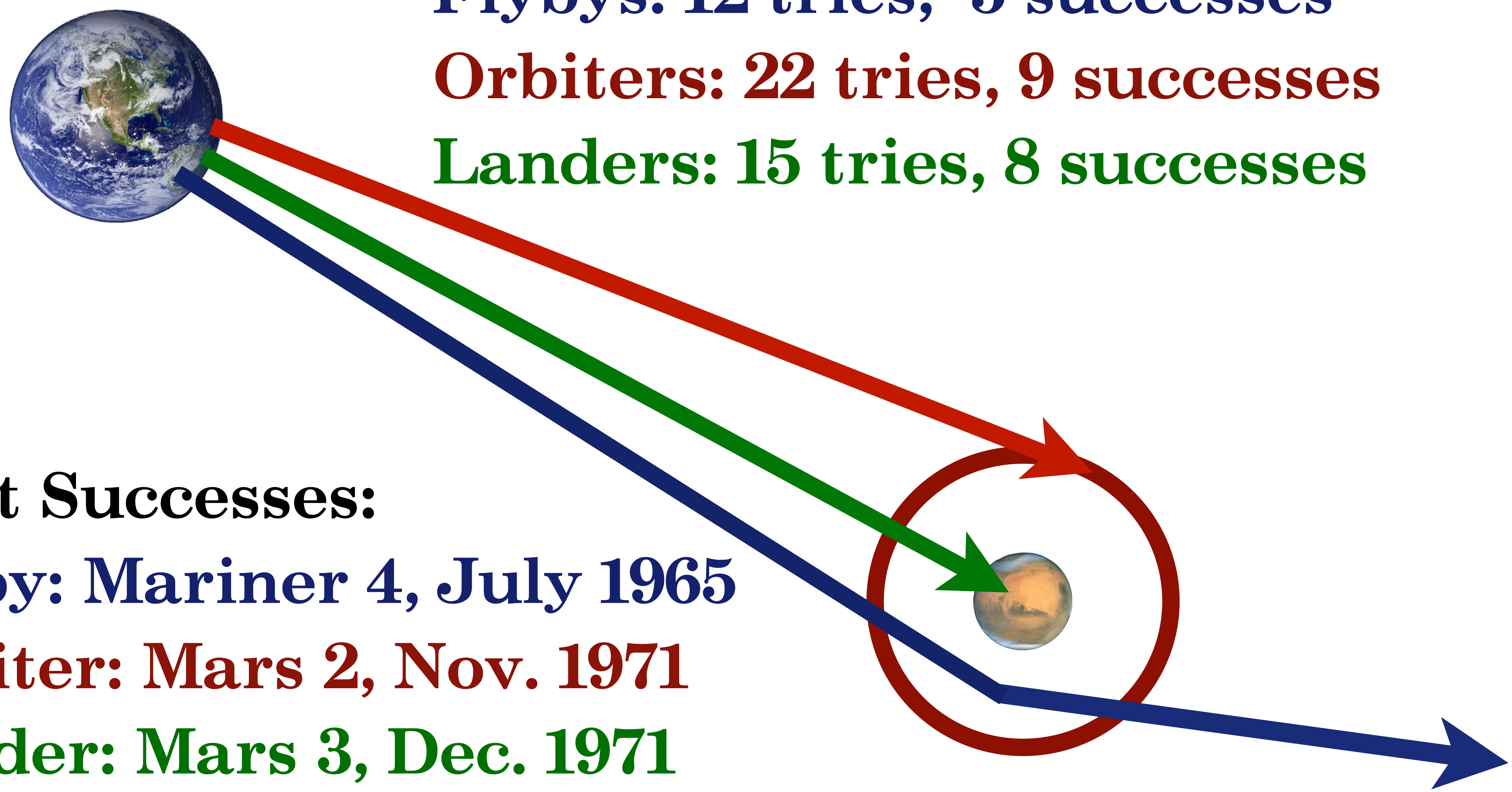
20 Attempts
5 Failures
0 Partial Successes
14 Successes
1 In Transit

Japan

1 Attempt
1 Failure

Mission Profiles

Flybys: 12 tries, 5 successes
Orbiters: 22 tries, 9 successes
Landers: 15 tries, 8 successes



First Successes:
Flyby: Mariner 4, July 1965
Orbiter: Mars 2, Nov. 1971
Lander: Mars 3, Dec. 1971

Next: A Look at 6 Missions in Particular...

1\.

Mars 1962A: Would You Like Armageddon with That?

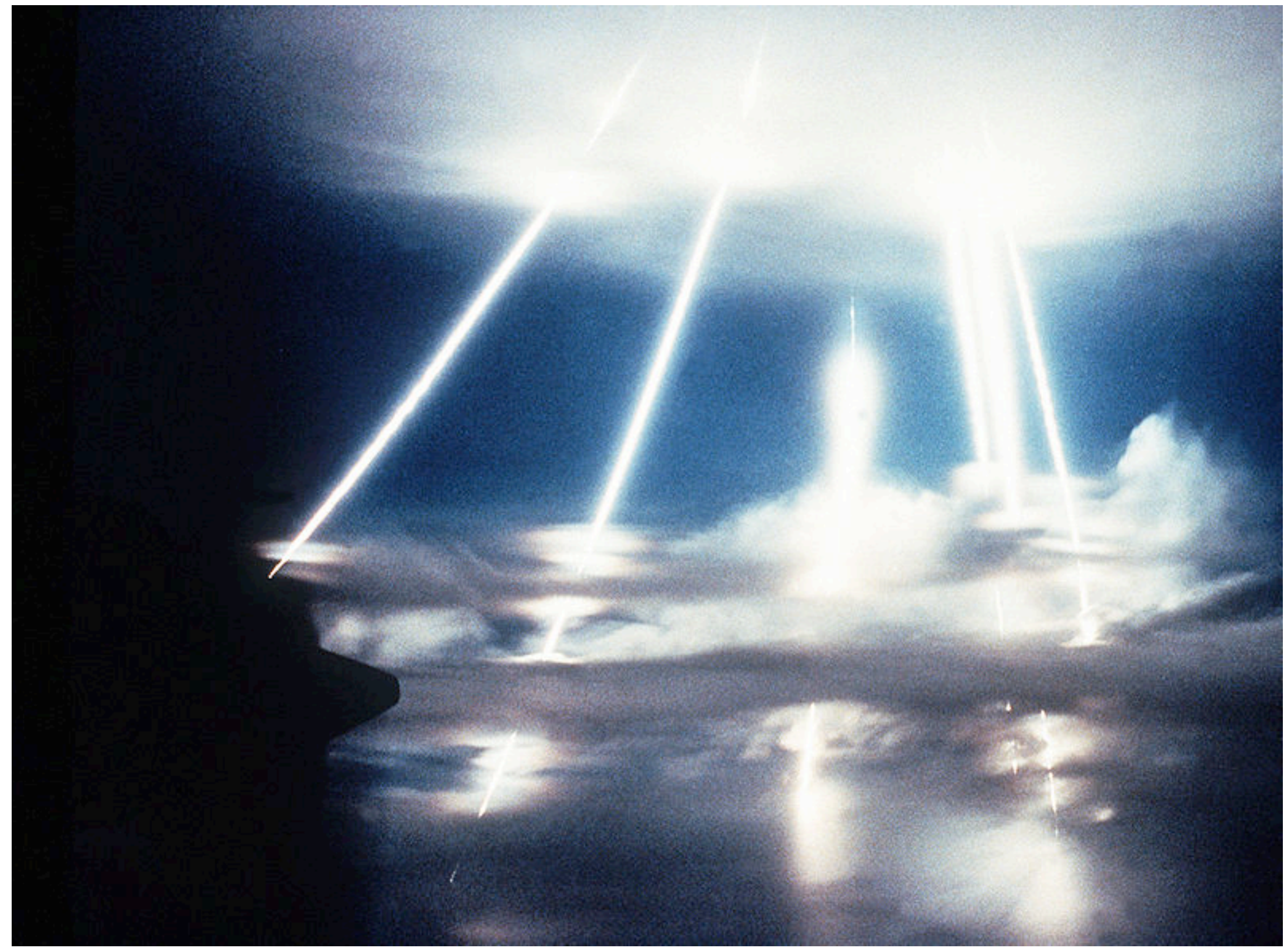
Mars 1962A was launched on 24 October 1962.

Intended as a flyby mission to Mars, it was successfully placed in Earth orbit.

When its Blok L upper stage ignited to place it into a Mars transfer trajectory, the turbopump siezed due to a lubricant leak, causing the engine to explode.

22 pieces of debris from the explosion were detected by the U.S. Ballistic Missile Early Warning System. They were initially identified as incoming nuclear warheads.

During the Cuban Missile Crisis (Oct. 22-28th 1962)



Since the USSR maintained secrecy about their space launches, there was no information in U.S. databases about the purpose of the launch.

Continued monitoring showed it to be in a decaying orbit not consistant with warheads.

2. Mariner 4: First Success

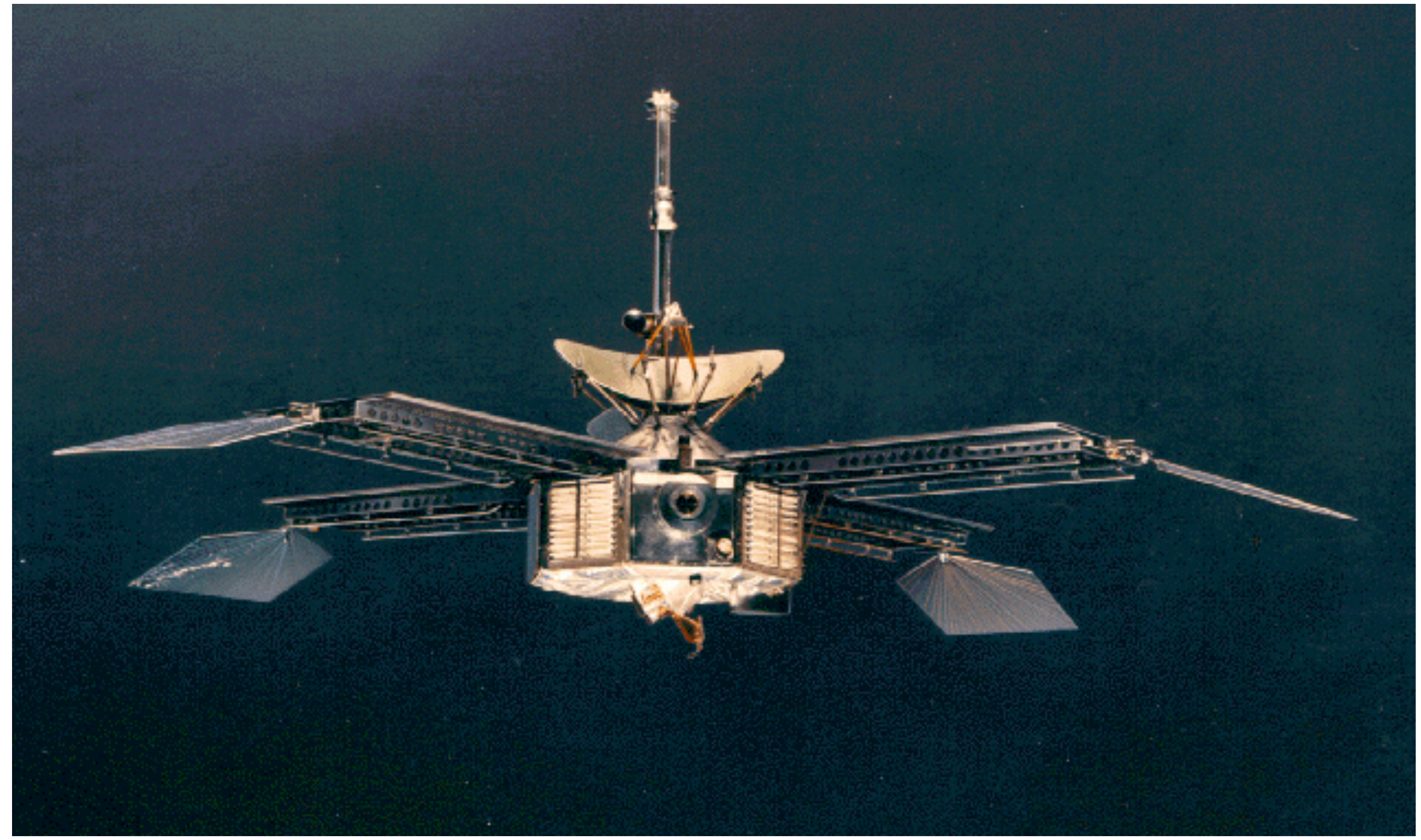
<u>Previous U.S. attempts:</u>

Mariner 3: Failed to detach from launch vehicle due to nose cone not detaching. Upper stage and space vehicle are still in solar orbit.

<u>Previous USSR attempts:</u>

Four flybys and one lander,all failed.

Four launch failures and one communications failure en route to Mars (Mars 1 Flyby).



Launched November 28, 1964, originally intended as a complementary probe with Mariner 3. After Mariner 3's failure, the mission was redesigned to give Mariner 4 the objectives of both missions, which is successfully completed.

It flew past Mars on July 14th and 15th, 1965 after 7.5 months in space and returned the first close-up pictures of another planet. 21 pictures were taken through red and green color filters (and a partial 22nd picture.) These were recorded on a tape recorder and played back to Earth through Aug. 3rd.

The spacecraft continued to return data from various instruments (solar plasma probe, cosmic dust detector) until Dec. 21, 1967, when operations were terminated.

The spacecraft is currently in a heliocentric orbit.

3. Zond 3: First USSR Semi-Success

Previous Mission:

Zond 2: Failed to deploy 1 solar panel, communications failed in transit to Mars.

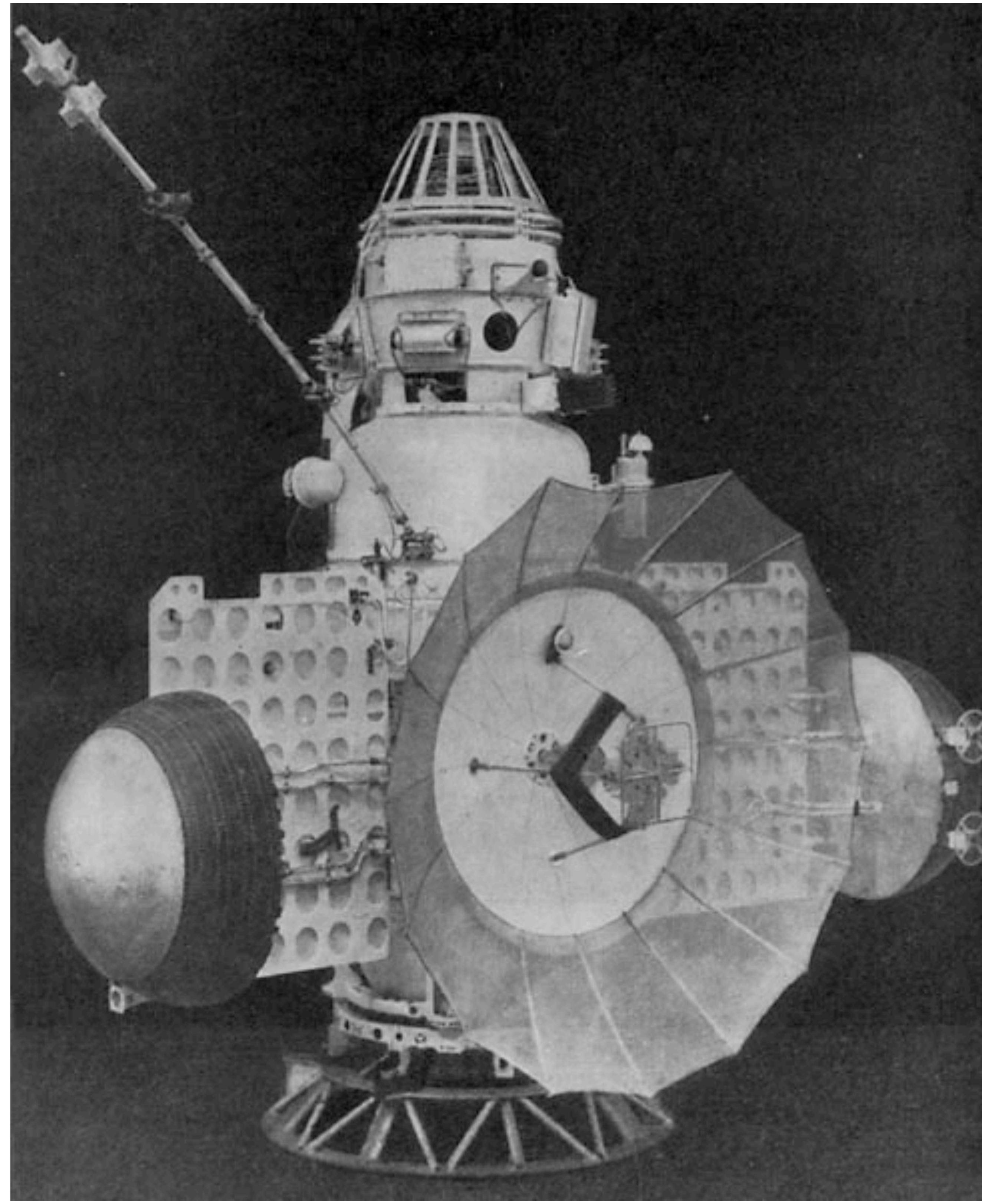
Zond 3 was originally designed as a sister spacecraft to Zond 2, but delays in preparing the spacecraft resulted in missing the launch window for Mars.

The mission was reworked as a lunar flyby and spacecraft test on a Mars trajectory that would not intercept the planet.

The craft flew by the Moon on July 20th, 1965 taking 23 images and 3 UV spectra of the lunar far side. It continued on an interplanetary trajectory.

At 22 and 31.5 million km the data tape was rewound and played back to test the communications system at the distances and times an actual Mars mission would require.

It continued sending scientific data from helocentric orbit for several months.



4. Mars 2 and Mars 3: First USSR Successes

Mars 2, Launched May 19, 1971:

Mars 2 successfully reached Mars orbit, but the lander entered Mars atmosphere at too steep and angle and crashed.

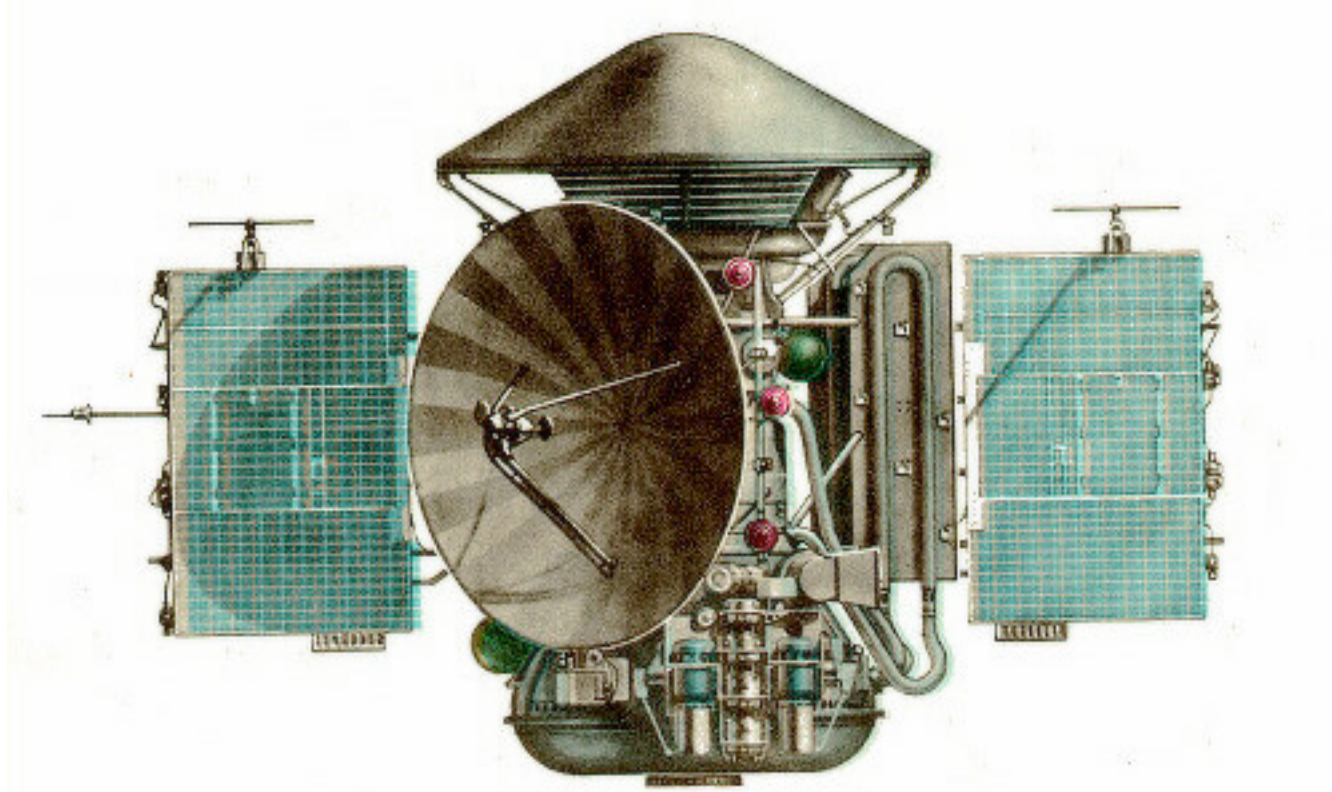
The orbiter continued to operate successfully for 362 orbits until 1972.

Mars 3: Launched May 28, 1971:

Mars 3 successfully reached Mars orbit and the lander landed successfully. The landers carried a tethered rover with a subsurface probe that could walk up to 15m from the lander to get data.

Unfortunately, the lander came down in a dust storm and only operated for about 20 seconds, only returning a partial image with practically no detail.

The orbiter was operated for 20 orbits, returning complementary data to the Mars 2 orbiter. They discovered atomic hydrogen and oxygen in the upper atmosphere, mountains up to 22km high, and a thin ionosphere.



Mars 2 and 3 Orbiter, with lander attached

Mars 2 and 3 Lander, capsule is about 4 feet across.

5. Viking 1 and 2: Success in the 70s

After the end of the Apollo program, long before the first flight of the Space Shuttle,Viking represented a major U.S. achievement in space exploration.

The missions became associated with both the U.S. bicentennial in 1976 as well as the 7th anniversary of Apollo 11.

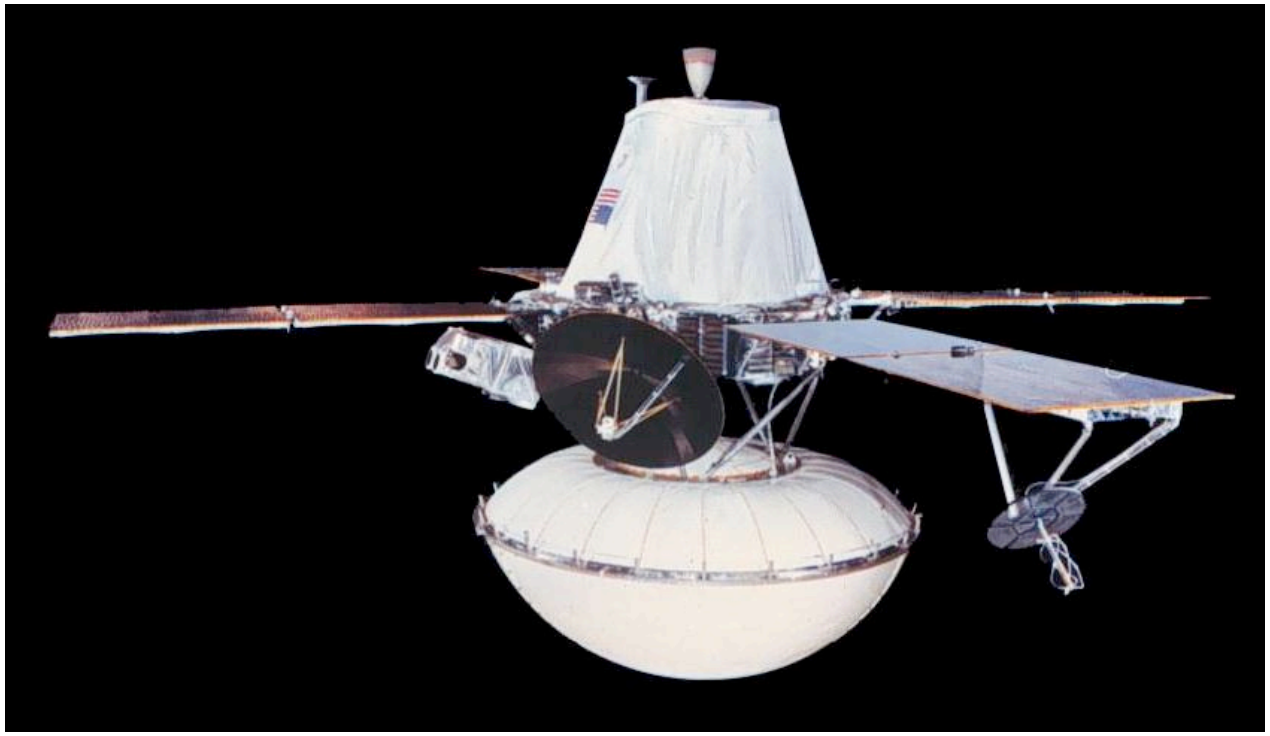
The landers were the first U.S. Mars landers. The orbiters were the second and third successful U.S. orbiters.

The missions were ambitious, with a complex, heavy lander with many experiments. The orbiters acted as data relays for the landers as well as having their own scientific and imaging missions.

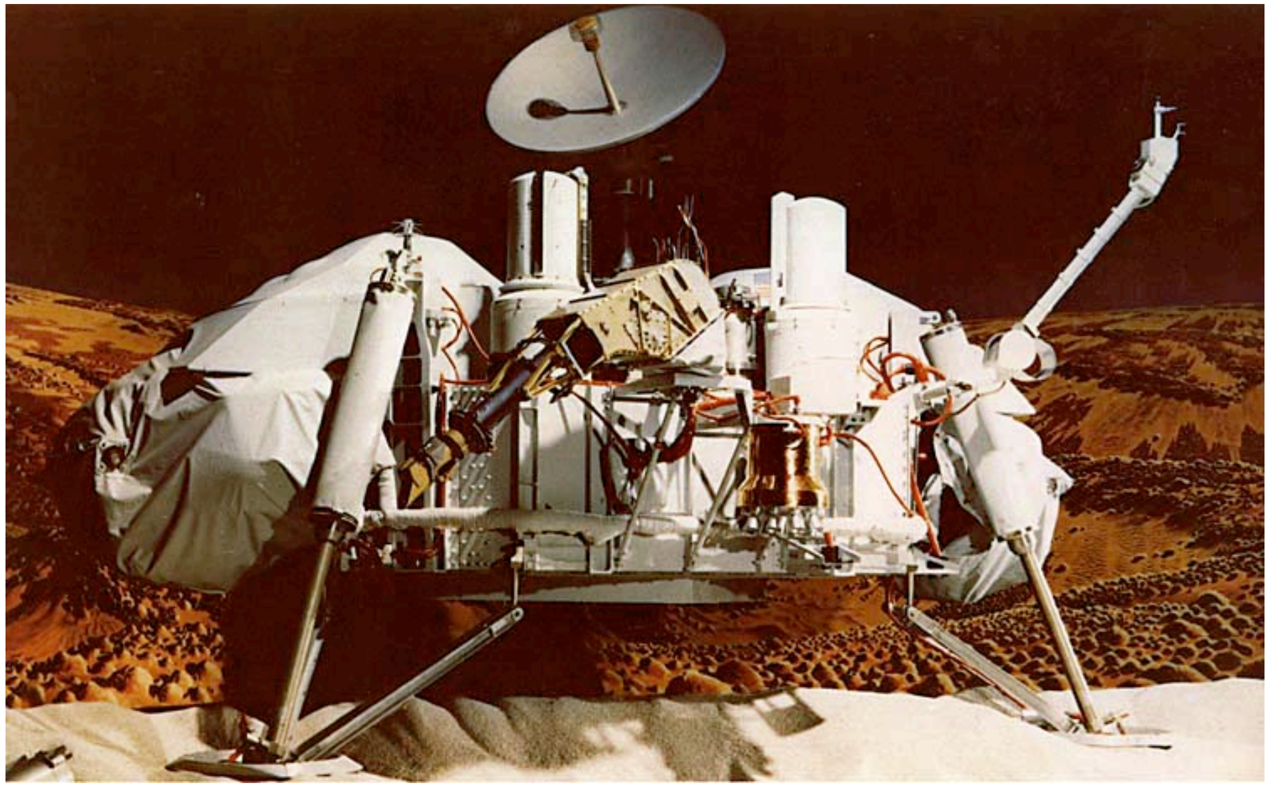
Lander 1 operated from July 20, 1976 to Nov 13, 1982. Lander 2 operated from Sept. 3, 1976 to April 22,1980.

Orbiter 1 ceased operation on Aug. 17, 1980 and is in a storage orbit predicted to last until 2019.

Orbiter 2 ceased operation on July 25, 1978 after a losing its attitude control propellant to a leak. Present orbital status unknown.



Viking Orbiter, with Lander Descent Module



Viking Lander

6. Phobos 1 and 2: Disappointment in Space

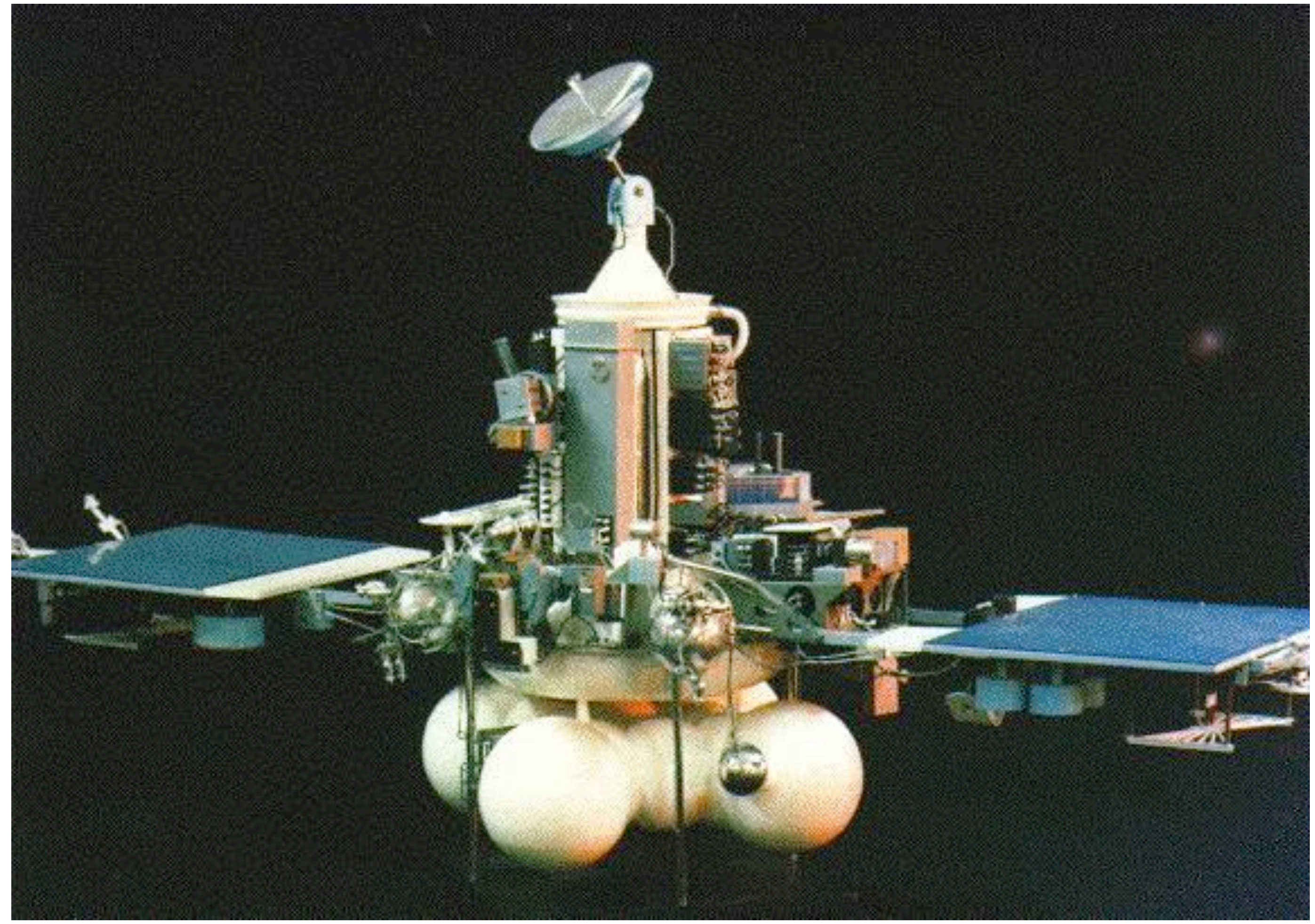
Launch: July 7, 1988 and July 12, 1988

The Phobos spacecraft had the mission of studying the Sun, the interplanetary medium, the atmosphere and surface,of Mars, and space plasma around Mars.

Also, they each carried a pair of landers destined for the martian moon Phobos, one each of a lander and a “hopper” rover to study the surface composition of the moon.

Contact with Phobos 1 was lost because of erroneous communications activating test software on the spacecraft that resulted in it losing its navigational lock on the Sun. It re-oriented itself to an angle that prevented the solar panels from producing power and contact was lost.

Phobos 2 reached Mars orbit and returned a few images. Contact was lost before the Phobos landers were deployed. This was thought to be a result of an on-board computer failure.



Phobos Space Probe, 1988

Electronics Problems in Space:

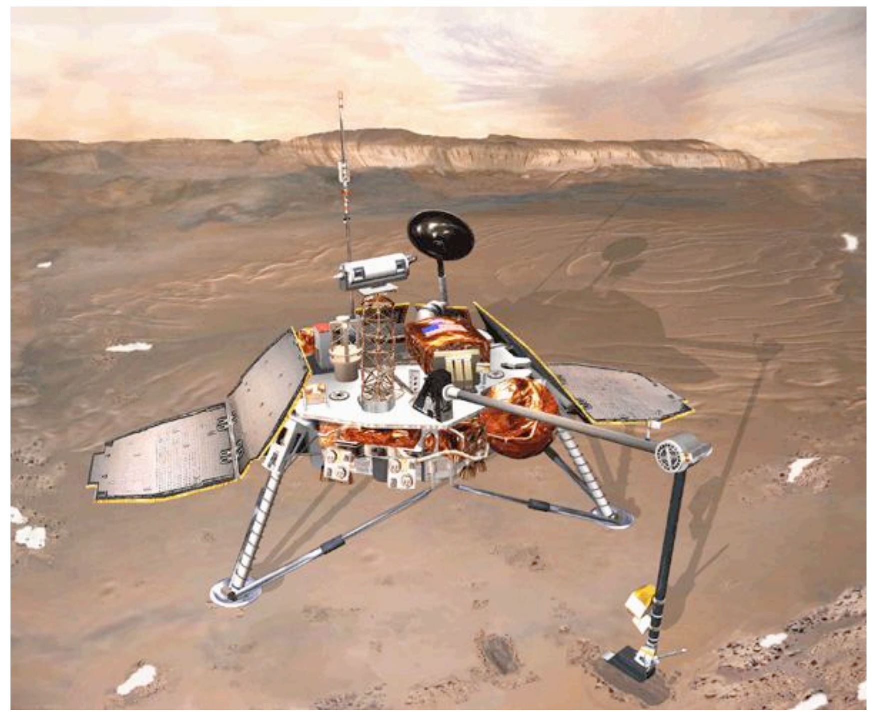
Degradation of electronic components in space is the cause or likely cause of at least 7 USSR Mars mission failures: Mars 2, Mars 3, Mars 4, Mars 5, Mars 6, Mars 7, and Phobos 2.

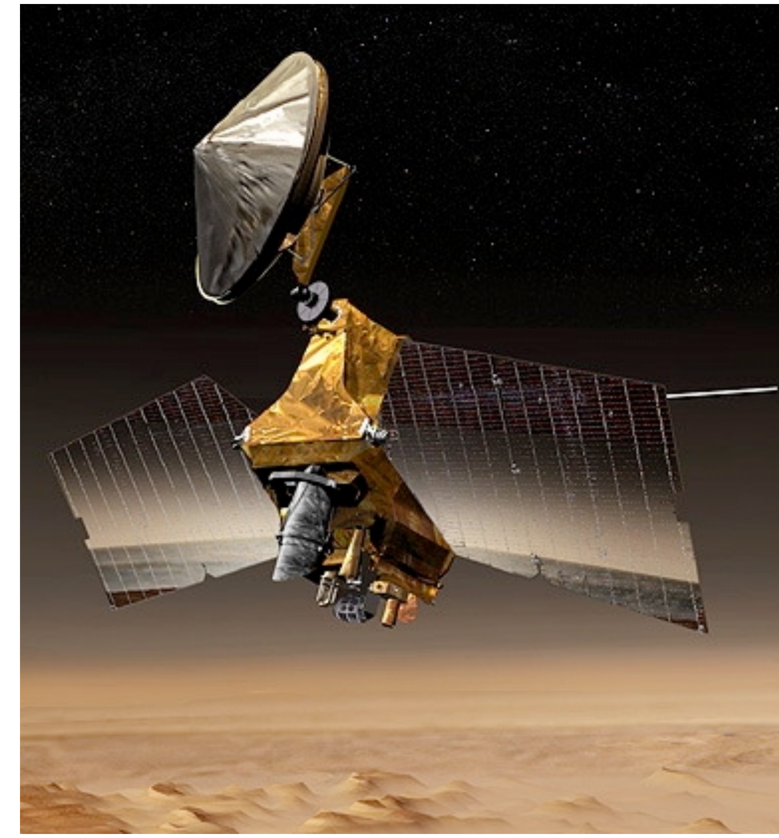
Electronics failures blamed on a solar flare caused the loss of the sole Japanese Mars mission, Nozomi.

Quick Run-Down of Some Others

Mars Global Surveyor
Operated over 10 years
from 1996 to 2006

Mars Polar Lander
Crashed during landing on Mars
in 1999 due to software design
fault.



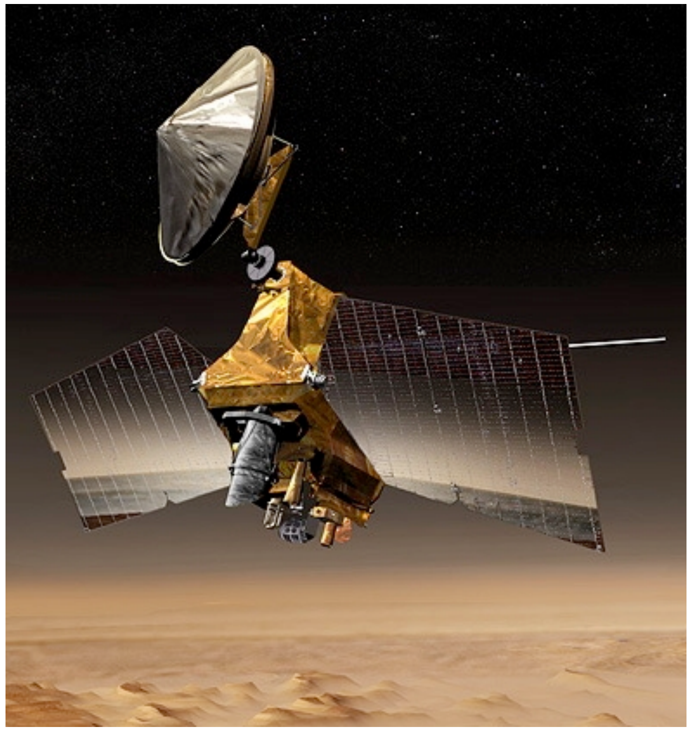


Mars Reconaissance Orbiter
Uses spy satellite tech to get
high resolution images of
Mars. Has seen Vikings, MERs
and possibly Beagle 2.

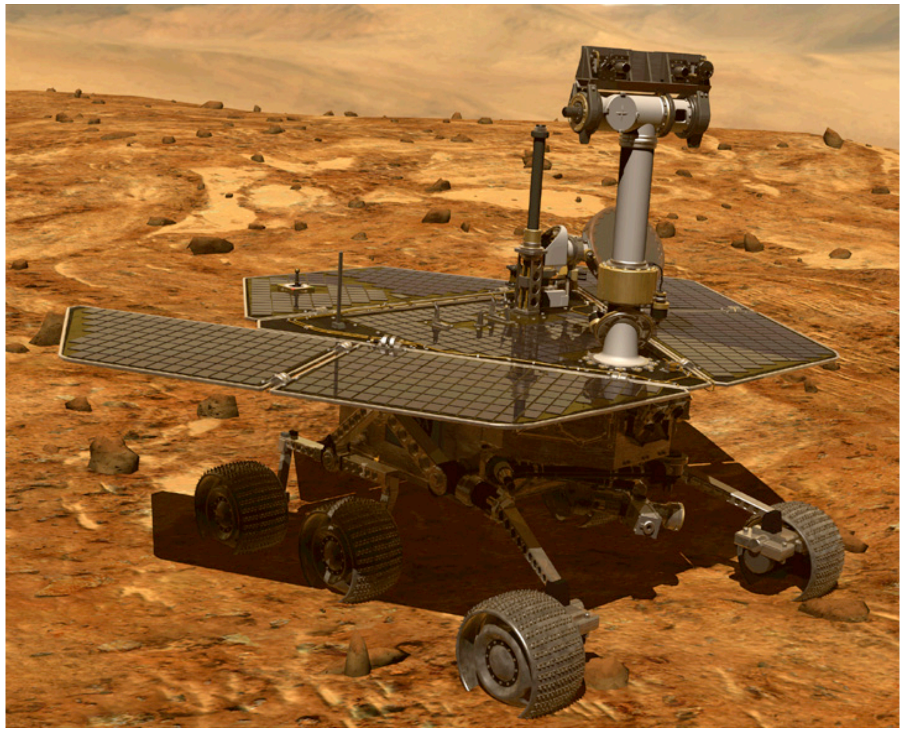
Beagle 2
Mars lander
crashed, reason
unknown but there
are many likely
causes due to
inadequate funding
for design and
testing.

Phoenix
Built from left-over
hardware from failed
missions.
Discovered water
ice just under the
surface of Mars.

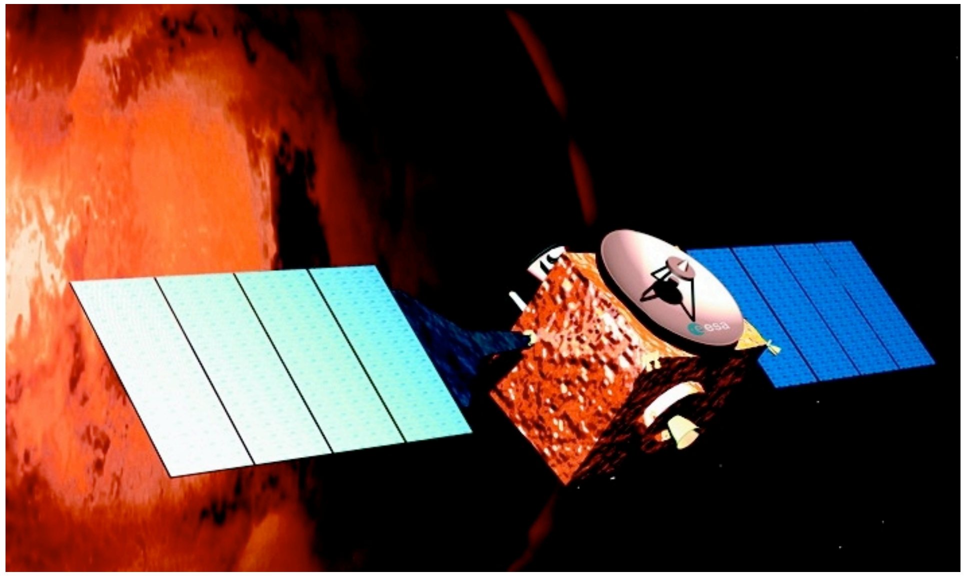
Still Working at Mars



Mars Reconaissance Orbiter
Science and data relay.
Since March 2006.



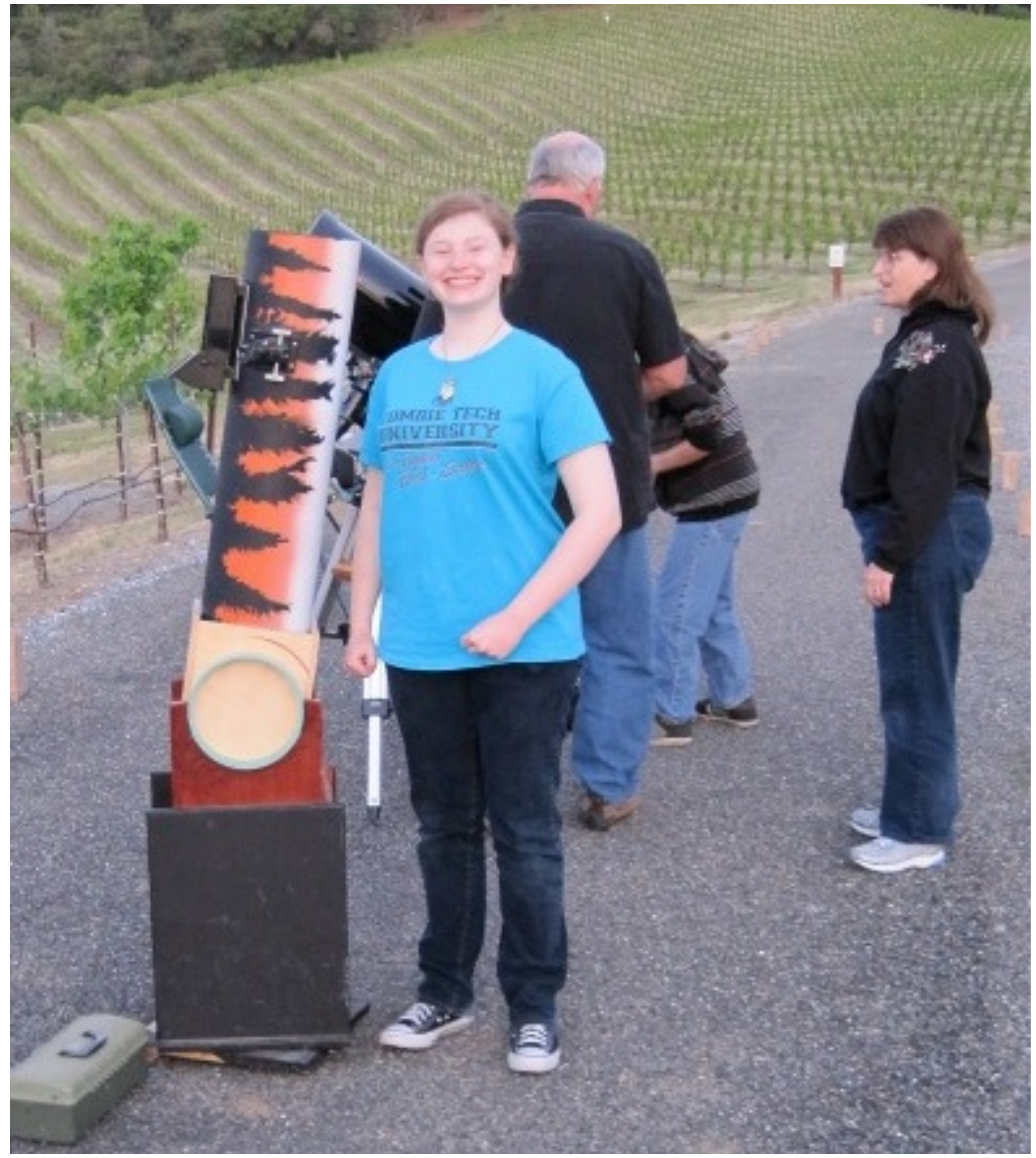
Mars Exploration Rover Opportunity
Surface materials and weather science.
Since January 2004.



Mars Express Orbiter
Science and data relay.
Since Dec. 2003

2001 Mars Odyssey
Science and data relay.
Longest operation of any Mars mission.
Since October 24, 2001.

Get Out and Enjoy It!



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