SPASH ASTRONOMY
CHAPTER 10: MARS
OVERHEAD LECTURE NOTES

1. What was the first machine to land on the surface of Mars and when did it land?
The first human-built machine **Viking 1** gathered data on the surface of Mars on July 20, **1976.** The dawn temperature was around -84 degrees C (-120° F) but by afternoon the air warmed to about -29°C (-20° F).

2. What and when can a small 7 cm aperture telescope see on Mars?
Mars comes within about 56 million kilometers **(35 million miles) of Earth** at which time a small telescope of only 7 to 10 centimeters' aperture will show features on its **reddish surface, including polar ice fields, clouds, and dusky markings.**

3. What is the rotation and revolution around the sun and how can we tell Mars has seasons?
Mars' rotation period is 24 h 37 m and the Martian year is nearly twice ours. Seasons (which would also be almost twice as long as our seasons) are easily observed by noting that **in the Martian hemisphere having summer the bright white polar cap shrinks away** and may disappear from view, **while the dusky markings darken and grow larger.**
The dark areas on Mars were mistaken for oceans again and thus called maria (wrong) but the brighter orange area did turn out to be dessert like as they claimed.

4. Are there really canals on Mars as we know them?
In 1869 Father Angelo Secchi in Rome mapped the streaky markings and called them canali. These features came to be called canals. In 1895, Percival Lowell concluded that the features really were canals-artificial ditches built by intelligent creatures to carry water. After spacecraft visits to Mars, however, we now know that a canal network does not exist as Lowell and some others drew it.

5. What are the Martian features named after?
Schiaparelli, a classical scholar as well as astronomer, named the larger Martian dark and light regions after historical, mythological, and geographic features of his native Mediterranean area. However, as on the moon, The moon craters were named after scientists. The largest canyon complex, big enough to stretch across the USA was named Valles Marineris (Valleys of Mariner).

6. What happened and when did the Orson Welles famous radio broadcast (The War of the Worlds) take place?

War of the Worlds

War of the Worlds, Orson Welles, And The Invasion from Mars

The ability to confuse audiences en masse may have first become obvious as a result of one of the most infamous mistakes in history. It happened on Halloween, Oct. 30, 1938, when millions of Americans tuned in to a popular radio program that featured plays directed by, and often starring, Orson Welles. The performance that evening was an adaptation of the

;ience fiction novel The War of the Worlds, about a Martian invasion of the earth. But in dapting the book for a radio play, Welles made an important change: under his direction the ay was written and performed so it would sound like a news broadcast about an invasion om Mars, a technique that, presumably, was intended to heighten the dramatic effect.

s the play unfolded, dance music was interrupted a number of times by fake news bulletins eporting that a "huge flaming object" had dropped on a farm near Grovers Mill, New Jersey. s members of the audience sat on the edge of their collective seat, actors playing news nnouncers, officials and other roles one would expect to hear in a news report, described ıe landing of an invasion force from Mars and the destruction of the United States. The roadcast also contained a number of explanations that it was all a radio play, but if ıembers of the audience missed a brief explanation at the beginning, the next one didn't rrive until 40 minutes into the program.

. How many voyages have there been to the surface of Mars?

he first three human-made craft sent by Russia to Mars where unsuccessful. The first successful anding on Mars was the **Viking 1** spacecraft. (7 years to they day we made it to the moon). On ept. 3, 1976 a duplicate spacecraft **Viking 2** landed. What was unusual was that in both landings vhat appeared smooth and flat for landing from orbit, ended up rock-strewn with boulders as wide ıs 3 m near the Landers.

Mars Observer The total cost of the Mars Observer mission including development, construction, launch, and ground support s estimated at **$980 million.**

What happened to the Mars Observer? An independent NASA review board concluded that the most likely cause of the loss of communication with the Mars Observer was a rupture in a line in the propulsion system during the start of fuel tank pressurization. The board cautioned that "There was no specific evidence about what actually transpired during the pressurization sequence".

Since its landing on July 4, 1997, **Mars Pathfinder** has returned 2.6 billion bits of information, including more than 16,000 images from the lander and 550 images from the rover, as well as more than 15 chemical analyses of rocks and extensive data on winds and other weather factors. The only remaining objective was to complete the high-resolution 360-degree image of the landing site called the "Super Pan," of which 83 percent has already been received and is being processed. The last successful data transmission cycle from Pathfinder was completed at 3:23 a.m. Pacific Daylight Time on Sept. 27, which was Sol 83 of the mission.

At the time the last telemetry from the spacecraft was received, Pathfinder's lander had operated nearly three times its design lifetime of 30 days, and the Sojourner rover operated 12 times its design lifetime of seven days.

"This mission has advanced our knowledge of Mars tremendously and will surely be a beacon of success for upcoming missions to the red planet," added Dr. David Baltimore, president of the California Institute of Technology, which manages JPL for NASA. "Done quickly and within a very limited budget, Pathfinder sets a standard for 21st century space exploration." Mars Pathfinder is a NASA Discovery Mission. Demonstrate NASA's commitment to low-cost planetary exploration by completing the mission for a total cost of $280 million dollars including the launch vehicle and mission operations.

Mars Global Surveyor

Wednesday, June 26, 2002 (DOY 170/19:00:00 to DOY 177/19:00:00 UTC)

Launch / Days since Launch = Nov. 7, 1996 / 2058 days
Start of Mapping / Days since Start of Mapping = April 1, 1999 / 1183 days
Total Mapping Orbits = 14,751
Total Orbits = 16,434

Note: Figures 10-14 a and b page 193 and Figures 10-15 a and b and Figures 10-18 a and b Phobos and Deimos

How much does the mission cost?
The Surveyor mission cost $154 million to develop. This development cost includes the price of the spacecraft, science instruments, ground support computers, mission flight plan design, and navigation design. In total, development was completed 7.7% under budget. Additional costs include $65 million for the Delta-7925 rocket that sent Surveyor to Mars, and about $20 million per year for mission operations and science analysis.

Sound expensive? To put the price of the mission in perspective, consider the fact that some recently released motion pictures have cost over $200 million in terms of filming, advertising, and distribution.

MARS CLIMATE ORBITER (Sept. 23, 1999) TEAM FINDS LIKELY CAUSE OF LOSS

Failure to recognize and correct an error in a transfer of information between the Mars Climate Orbiter spacecraft team in Colorado and the mission navigation team in California led to the loss of the spacecraft last week, preliminary findings by NASA's Jet Propulsion Laboratory internal peer review indicate.

"People sometimes make errors," said Dr. Edward Weiler, NASA's Associate Administrator for Space Science. "The problem here was not the error, it was the failure of NASA's systems engineering, and the checks and balances in our processes to detect the error. That's why we lost the spacecraft."

The peer review preliminary findings indicate that one team used English units (e.g., inches, feet and pounds) while the other used metric units for a key spacecraft operation. This information was critical to the maneuvers required to place the spacecraft in the proper Mars orbit.

The **Mars Polar Lander was lost during its attempted landing on Mars, Dec. 3, 1999.** Within two weeks, NASA began obtaining high resolution images of the intended landing site using the camera onboard the orbiting Mars Global Surveyor in an attempt to locate the lander on the Martian surface. No sign of the Mars Polar Lander was found in the NASA searches. In an independent search, starting about the same time, NASA and NIMA began working together to analyze images of the planet's
surface.

Project Cost
$110 million for spacecraft development, $10 million mission operations; total $120 million (not including launch vehicle or Deep Space 2 microprobes).

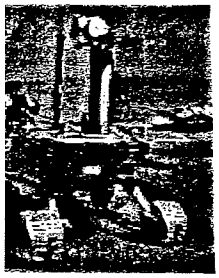
2001 Mars Odyssey is an orbiter carrying science experiments designed to make global observations of Mars to improve our understanding of the planet's climate and geologic history,

cluding the search for water and evidence of life-sustaining environments. The mission will extend for ıore than a full Martian year (two-and-a-half Earth years).

lars Odyssey was launched April 7, 2001 on a Delta II rocket from Cape Canaveral, Florida, and :ached Mars on October 24, 2001, 0230 Universal Time.

ı June 2002, researchers using the **Mars Odyssey** spacecraft announced that they had found water ice under the ırface of Mars. These attributes, coupled with a carbon dioxide-rich atmosphere, would have provided the ecessary environment for the evolution of microbes similar to the fossils found in ALH84001.

)uring the past few months, while the boom was in the stowed position, the instrument suite has provided ignificant information about the hydrogen abundance on Mars. This allowed scientists to conclude there are large uantities of water ice just below the surface.



2003 Mars Exploration Rovers

Spacecraft
Launch: May-July 2003
Arrival: January 2004
Science instruments: Panoramic Camera, Miniature Thermal Emission Spectrometer, Mössbauer Spectrometer, Alpha Particle X-ray Spectrometer, Microscopic Imager

Overview In 2003, two powerful new Mars rovers will be on their way to the red planet. With far greater mobility han the 1997 Mars Pathfinder rover, these robotic explorers will be able to trek up to 100 meters (about 110 yards) ıcross the surface in a Martian day. Each rover will carry a sophisticated set of instruments that will allow it to :earch for evidence of liquid water that may have been present in the planet's past. The rovers will be identical to :ach other, but will land at different regions of Mars.

Mars Express

Spacecraft
Launch: June 2003
Arrival: December 2003
Mass: 1,042 kilograms (2,297 pounds)
Science instruments: Energetic Neutral Atoms Analyzer, Geochemical Lander, High/Super Resolution Stereo Color Imager, Radio Science, Subsurface Sounding Radar/Altimeter, Infrared Mineralogical Mapping Spectrometer, Planetary Fourier Spectrometer, Ultraviolet and Infrared Atmospheric Spectrometer

Overview

NASA is participating in a mission planned by the European Space Agency and the Italian space agency called Mars Express, which will explore the atmosphere and surface of Mars from polar orbit. The spacecraft will carry a science payload with some heritage from European instruments lost on the ill-fated Russian Mars '96 mission, as well as a communications relay to support lander missions. Mars Express will itself carry a small lander as well.

The mission's main objective is to search for sub-surface water from orbit and deliver a lander to the Martian surface. Seven scientific instruments onboard the orbiting spacecraft will study the Martian atmosphere, the planet's structure and geology.

The lander is called Beagle 2 after the ship in which Charles Darwin set sail to explore unchartered areas of the Earth in 1831. After coming to rest on the surface, Beagle 2 will perform exobiology and geochemistry research.

What did Vikings 1 and 2 discover?
Martians, no deserted cities, no canals, and no strange vegetation. **Mars turned out to be a desolate, cold,** yet beautiful desert. **Most rocks and soil particles were covered with a coating of rust like, reddish iron oxide minerals.** The **daytime sky of Mars is reddish-tan instead of blue because of fine red dust stirred** from the surface into the air by winds and deposited even on rock tops as it settles out of the air. (Figure 10-5 page 185 and Figure 10-13 page 193)

9. What is the Marian Atmosphere Like?
Like Venus, **Mars has a very thin atmosphere that is mostly carbon dioxide,** probably generated chiefly by planetary degassing through volcanic activity.

10. Martian climate facts:
1. The Martian climate is very cold and dry by Earth standards. **Air Temps. ranged from -123° F at night to -20°F in the afternoon.**
2. The **soil** absorbs sunlight and actually **gets above freezing on some summer afternoons.**
3. **Winds were gentle,** usually 11 mph but gusts exceeded 31 mph.
4. The **air pressure was only about 0.7% of that at sea level on Earth.** This **corresponds to pressure at about 100,000 feet on Earth.**
5. **Frozen H_2O exits at each pole year-round.**
6. The hemisphere that is having winter gets **so cold at the pole that the CO_2 freezes out of the atmosphere forming a "dry ice" layer.**

11. What is the rock and soil on Mars like and how do we know?
Although no spacecraft has yet returned samples from Mars, we already have some Martian rocks in our museums as they fell in the Antarctic as meteorites. There are about a dozen of these meteorites that are basaltic lavas with much younger ages, only about 1.3 billion years, and gases contained in them are the same composition as the Viking landers measured in the air on Mars. Researchers didn't realize until the 1980's that they really had rocks from Mars! They believe that meteorite impacts blasted these pieces off Mars, then they drifted in space and eventually hit Earth. These Martian meteorites show that Mars has basalt lavas, a mantle composition somewhat similar to Earth's, and large amounts of subsurface water or ice. The limitation of these Martian meteorites is that we don't know exactly what sites on Mars they came from. Note: Figure 10-16 page 196.

12. What are the two Great Mysteries of Mars?
The first great mystery is "How could Mars have ever had a climate that allowed flowing rivers, not to mention possible rain or lakes? They only leads to this mystery at this time are that the Viking and other spacecraft have proved that the atmosphere used to be much denser with 10 to 100 times as much N_2 and CO_2. Also the total H2O ejected by volcanoes would have been enough to make a water or ice layer from tens of meters to a few hundred meters deep over the whole planet.

ıe intensely rusted state of Martian iron minerals explains the reddish color of the Martian soils.

ıe second great mystery is, "Where are the Martians?" The Viking mission was specifically :signed to look for life on Mars. Of the five Viking experiments involved, two gave negative sults, but three gave ambiguous results. The Viking showed that Mars "is not teeming with life om pole to pole".

3. Name two facts about each of Mars two satellites, Phobos and Deimos:

ı 1877, the American astronomer Asaph Hall charted the positions of two Martian moon, naming ıe inner satellite Phobos ("fear") and the other one Deimos ("terror") after the chariot horses of lars in Greek mythology.. Close up photographs show these moons to be strange, potato-shaped, ratered chunks of rock. (pictures page 230)

'he craters of Phobos and Deimos were caused by collisions with small bits of meteoritic debris. 'he largest crater on Phobos is 8 km (5 mi) across. It is named Stickney, the maiden name of Mrs. lall, who encouraged her husband's successful search for the satellite. Many researchers believe 'hobos and Demos originated as asteroids but were later captured into orbit around Mars.

4. What Lesson in Comparative Planetology can We Learn about the Topography of Earth, 'enus, and Mars

Worlds smaller than Mars preserve ancient surfaces dominated by external forces of cratering that haped the planet. For worlds around the size of the Moon and Mars, internal energy is significant nough that volcanic forces break through the lithosphere and resurface parts of the planet. Worlds arger than Mars have surfaces dominated by these internal forces, including volcanism and tectonic estructuring.