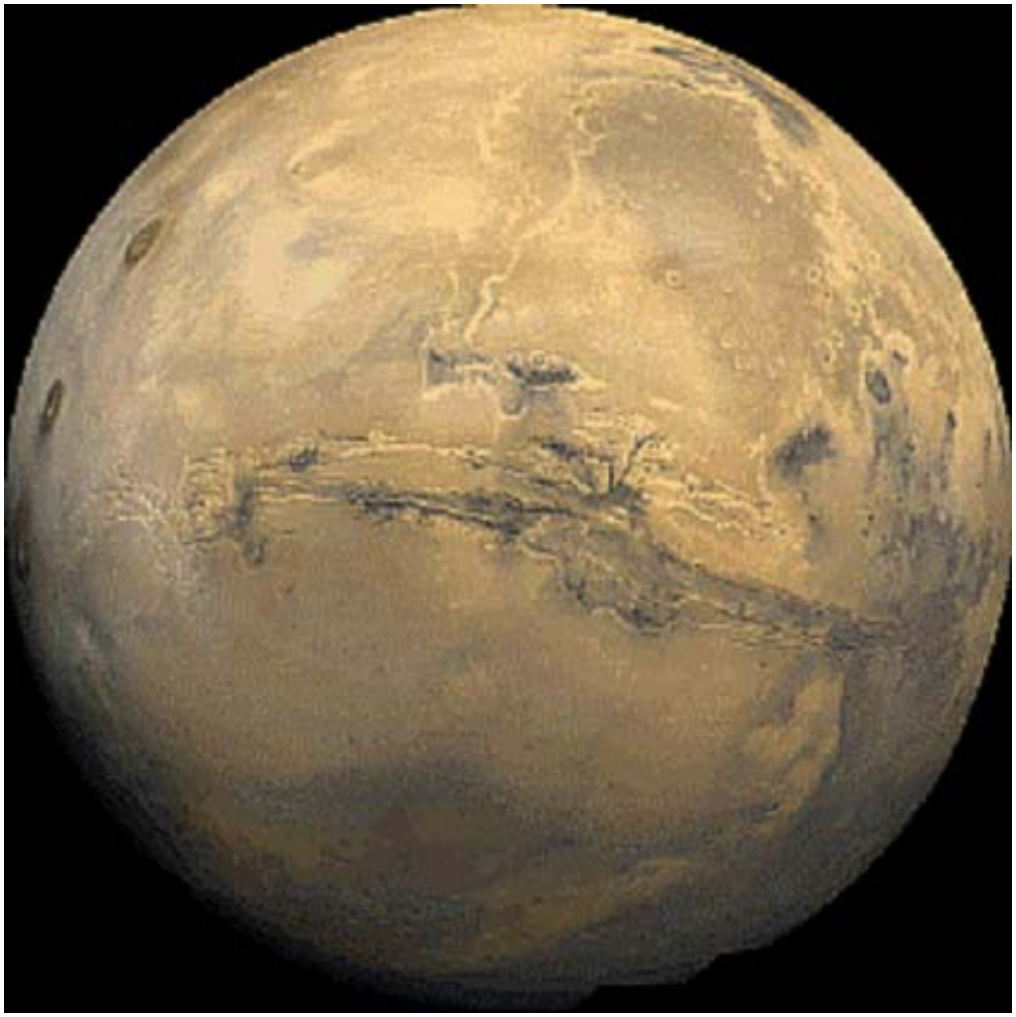
THE BASICS OF RADAR ASTRONOMY



http://nssdc.gsfc.nasa.gov/imgcat/html/object_page/vo1_mg07s078.html

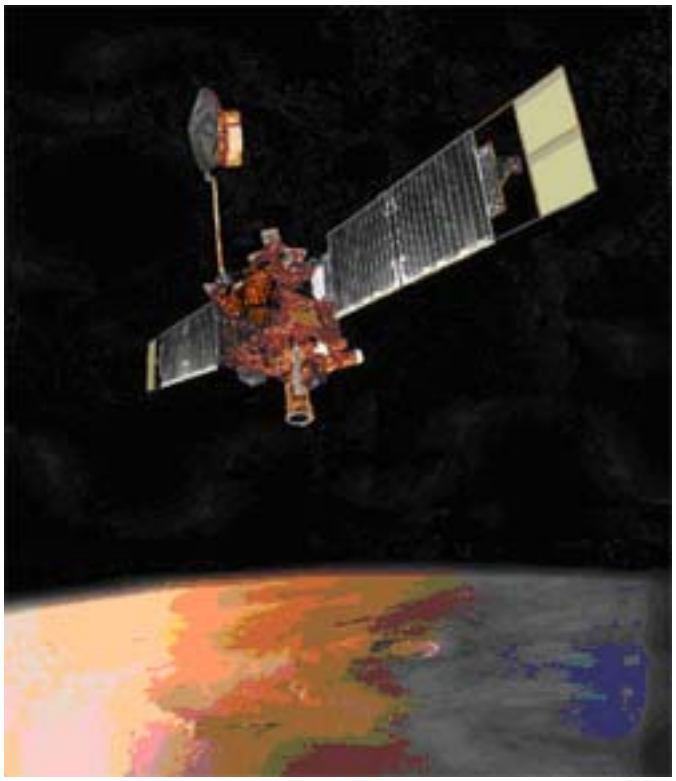
THE BASICS OF RADAR ASTRONOMY

Introduction

Radar technology is used all around us and in many ways it has helped shape the world that we see, or better yet, what we cannot see. The GAVRT unit on radar will cover some of the basic science concepts of radar and how it is used in determining the distances of objects in the solar system as well as mapping their geological areas.

NASA selected two landing sites for the twin robotic rovers, which were carefully analyzed by various remote sensing techniques, including radar. Consideration for the landing sites had to balance between the safety of the landing of the rovers and the science they would conduct on Mars. Radar, which provides information about a surface's roughness, was therefore crucial to the selection of the landing sites.

The GAVRT unit will present a basic understanding of how important radar is in the exploration of space and with special emphasis on the planet Mars.



Artwork by Corby Waste

http://mars.jpl.nasa.gov/mgs/images/highres.html

Principles of Radar

Radar is a type of electromagnetic radiation whose name is an acronym for '***Ra***dio ***D***etection And ***R***anging' and was initially discovered using our understanding of radio waves. Radar developed primarily as a military instrument and the technology evolved rapidly during World War II. After the war, it improved tremendously and was soon being used for many different purposes.

Planetary radar operates by sending and receiving a narrow beam of electromagnetic energy either in the microwave or radio range into space from an antenna. The object reflects the radio waves back to Earth where they are detected by the same antenna that sent the signal. The time between sending the signal and receiving the signal can be measured with great precision. Because the speed of the electromagnetic energy is known, the distance to an object can be determined. In other words, radar works much like sound transmitted from a human being or some other device which returns in the form of an echo.

The velocity or speed of the object is measured by applying the Doppler principle. If the object is approaching the radar antenna, the frequency of the returned signal is greater than the frequency of the transmitted signal. If the object is receding from the radar antenna, the returned frequency is less and if the object is not moving relative to the antenna, the return signal will have the same frequency as the transmitted signal. This is familiar to anyone who has been passed by an ambulance and its siren. As it approaches, the siren's pitch is higher than when it is stationary, because its frequency has increased. Similarly, as the siren recedes, the frequency is decreased and the pitch lowered.

Applications of Radar

As previously mentioned, radar technology is used all around us. One of radar's primary uses is in air traffic control, where airports use radar to track airplanes and for navigational purposes. The military uses radar to detect the enemy as well as to guide weapons. Weathermen use radar to track storm systems such as hurricanes and tornados and we are all too familiar with radar being used to detect speeding motorists. Measuring distances and mapping geological areas have become an important use of radar, especially the topography of planets, asteroids, or comets in the solar system.

Science Application

The key to our modern determination of the solar system dimensions and features is radar. In 1946 radar beams from the earth were reflected back from the moon and scientists were able to reveal through radar technology that the moon had sand-like structures. This observation was made before any landings on the moon were made.

Radar contact in the 1950s was established with Venus and the Sun, thereby opening a new field of astronomy—radar astronomy. With this new area of astronomy, hundreds of special bodies in the solar system have been studied by radar to map out their surface, measure their distance from earth, and to follow their orbits.

There are different types of radar systems that are used for the scientific study of the solar system. Ground based radar is an important tool in obtaining information about these objects in the solar system. It can be used for basic orbit determinations (distance and speed versus time) of objects. The next level is to assemble all the radio echoes from a portion of an object into a radar image. These techniques can also be applied from a spacecraft radar, flying past a solar system object or in orbit, around the object.