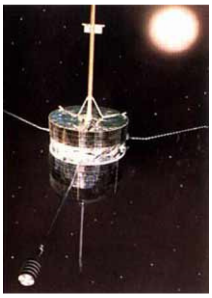
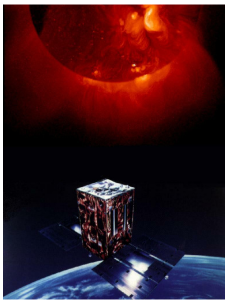
Sun – Part 30 -Solar exploration 1


Pioneer 6 spacecraft


Solar Maximum Misssion


Yohkoh satellite

Solar observation and investigation from Earth has taken place for centuries, and there are a number of dedicated solar observatories in several countries. Deeper knowledge of the Sun has also, and continues, to be obtained from space missions. From 1959-1968, NASA's Pioneer 5, 6, 7, 8 and 9 were the first satellites designed to observe the Sun from space. Orbiting at distances similar to that of Earth, they made the first detailed measurements of the solar wind and the solar magnetic field. Pioneer 9 was the most successful, transmitting data until May 1983.

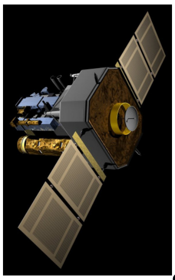
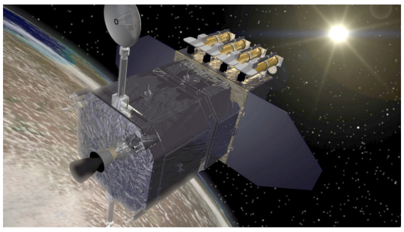
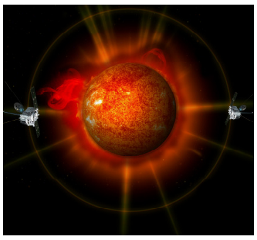
In the 1070s, the two German Helios probes, launched by NASA, studied the Sun and interplanetary space from well inside Mercury's orbit. Helios 1, launched in 1974, was put into an orbit only 45 million km from the Sun at perihelion, closer than any previous probe. In 1976, Helios 2 orbited as close as 43 million km as it also studied the Sun and interplanetary space. NASA's Skylab, launched in 1973, included a solar observatory, the Apollo Telescope Mount. This contained six telescopes for observing the Sun's chromosphere and corona at X-ray, ultraviolet and visible wavelengths. The on-board astronomers made the first time-resolved observations of the solar transition region and ultraviolet emissions from the corona. Discoveries included first observations above coronal mass ejections and coronal holes, the latter now known to be associated with solar wind.

In 1980, NASA launched the Solar Maximum Mission satellite. It was designed to observe gamma ray, X-ray and ultraviolet radiation from solar flares during the solar cycle maximum. A few months after launch, electronic failures caused the probe to go into standby mode for three years until, in 1984, the space shuttle Challenger retrieved the satellite, repaired the electronics, and released it back into orbit. The mission then took thousands of images of the corona before re-entering Earth's atmosphere in late 1989.

Japan's Yohkoh satellite was launched in 1991. Meaning 'sunbeam' Yohkoh's four instruments observed solar flares and other solar phenomena at X-ray and gamma ray wavelengths. Data obtained allowed for identification of several types of flares, and showed that the corona away from peak activity regions was much more dynamic and active than previously thought. The satellite observed a full solar cycle, but went into standby mode in 2001 when an annular eclipse caused it to lock onto the Sun. It was destroyed in 2005 during atmospheric re-entry.

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, www.en.wikipedia.org,

Sun – Part 31 - Solar exploration 2

SSOHO satellite   Solar Dynamics Observatory   STEREO – artist's diagram   Parker Solar Probe

In 1995, the joint ESA and NASA Solar and Heliospheric Observatory (SOHO) satellite was launched. One of the most important solar missions, its twelve instruments were designed to observe the Sun in ultraviolet and visible light, study the solar wind and measure small oscillations on the Sun's surface. Intended as a two year mission, its successful mission was extended to 2012. Situated at the L1 Lagrangian point between the Sun and Earth, around 1.5 million km from Earth in the sunward direction and Sun where the gravitational pull from each is equal and the Sun can be observed without interruption of eclipses from the Earth, SOHO provided a constant view of Sun at many wavelengths. It also enabled discovery of more than 2,000 comets, mostly tiny sungrazing comets that incinerate as they pass the Sun.

The SOHO mission was so successful that, in 2010, the follow-up Solar Dynamics Observatory (SDO) was launched by NASA. Its objective is to improve understanding of solar activity and its effects on Earth. It instruments measure solar oscillations and the magnetic fields in the photosphere to determine how internal solar processes relate of surface activity, closely monitor the corona, and solar emissions at extreme ultraviolet wavelengths.

All these satellites have observed the Sun from the plane of the ecliptic, so have only observed the solar equatorial region in detail. In contrast, the joint ESA-NASA Ulysses probe was launched in 1990 to study the solar wind particularly from the unexplored polar regions. It travelled to Jupiter to slingshot into an orbit far above the ecliptic. Observing the solar wind and magnetic field strength at high solar latitudes, it found that the solar wind was moving at about 750 km/s, slower than expected. Large magnetic waves that scattered galactic cosmic rays were also found emerging from high latitudes. Ulysses ceased operations in 2009.

The Genesis probe was launched in 2001 by NASA in an effort to increase understanding of the composition of the interior of the Sun. It was designed to collect samples of the solar wind and return them to Earth in order to allow for direct measurement of the composition of solar material. Positioned at the L1 Lagrangain point, it worked from 2001 to 2004. It then returned to Earth but was damaged in a crash landing from parachute failure. However, some usable samples were recovered from the sample-return capsule which it had dropped into the atmosphere.

NASA's Solar Terrestrial Relations Observatory (STEREO). Launched in 2006,. the two identical spacecraft were sent into orbits that cause them to respectively pull ahead or fall behind Earth. This enables three-dimensional imaging of the Sun and solar phenomena. Instruments on each craft enable observation of the inner and outer corona and the chromosphere at four different wavelengths, and of coronal mass ejections. In addition, radio burst trackers trace radio disturbances in the solar wind, and experiments study energetic particles from the Sun and interplanetary magnetic field.

In aUGUST 2018, NASA launched the Parker Solar Probe. Approaching as close as 6.2 million km of the solar surface (photosphere during its almost 7 year mission, it will be the first spacecraft to fly into the low region of the very hot solar corona. The probe will reach that close to the Sun in late 2024, after a series of gravitational assists achieved via 7 flybys of Venus. The probe will measure and analyse the structure and dynamics of the solar corona and the Sun's magnetic field, the energy flows which heat the corona and initiate and accelerate the solar wind, and the mechanisms which accelerate energetic particles. A solar shield will protect the craft and its instruments from the extreme heat and radiation experienced that close to the Sun. The probe will reach that close to the Sun in 2014, after a series of gravitational assists achieved via 7 flybys of Venus.

Other countries are also interested in solar space research. The Indian Space Research Organisation has scheduled the launch of a 100 kg satellite, Adiya, for 2017-2018. Its main instrument will be a coronagraph for studying the dynamics of the solar corona

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, www.en.wikipedia.org