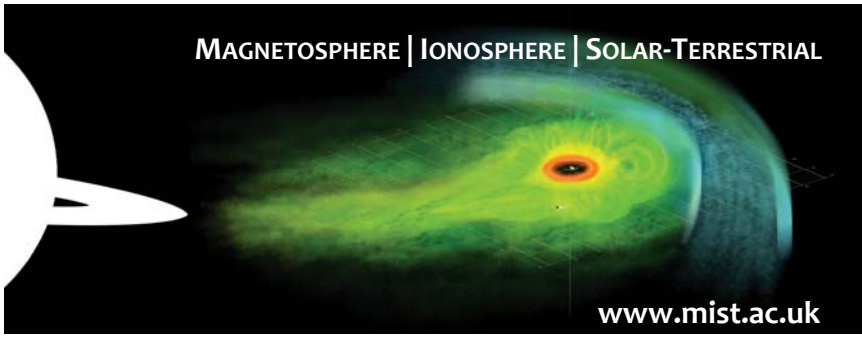
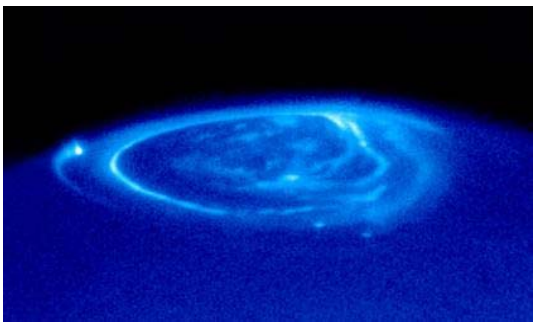


PLANETARY EXPLORATION

How British scientists are exploring the magnetic fields and plasma environments of our planets

Why explore other planets?
By exploring other planets, and comparing them with Earth, we can learn more about the environment in which we live, how it protects us and how it has changed over time. MIST scientists in the UK are world-leaders in studying the processes that control planetary magnetic environments, known as magnetospheres.

What is a planetary magnetosphere?
It is the region surrounding a planet where the planet's magnetic field dominates the local environment. All the planets in the solar system have magnetospheres. Earth, Mercury, Jupiter, Saturn, Uranus and Neptune have internal magnetic fields. The shape of their magnetospheres is determined by their strong internal magnetic field and the solar wind of charged particles blowing from the Sun into interplanetary space. Mars and Venus have weak magnetic fields, thus their magnetospheres are created as the solar wind is diverted to flow around the ionospheres of each planet.



▲ ***Jupiter's aurora as seen by the Hubble Space Telescope [image: NASA/ESA and Univ. Michigan]***

Can we see a magnetosphere?
Although magnetic fields are invisible, the aurora created by particles in magnetospheres can be imaged with special cameras. UK scientists have used the Hubble Space Telescope to take amazing pictures of the aurora of Jupiter and Saturn. By sending spacecraft to other planets, we can also directly measure the magnetic fields and plasmas that surround them.

Why are magnetospheres important?
Strong magnetospheres protect planets and their atmospheres from direct bombardment by the solar wind. For example, Earth's magnetosphere is a key reason why our planet has an atmosphere and abounds with water, as opposed to Mars. Thus life on Earth might not exist in its current form without this protection. Strong magnetospheres also produce low frequency radio emissions. These may provide a way to detect magnetospheres in other solar systems and are an important target for new radio telescopes now being built.

Satellites, including those for communications and GPS, are affected by variations in the Earth's magnetic and plasma environment. With modern life increasingly benefiting from space technology Earth's magnetic environment can significantly impact on our lives (see MIST briefing paper on Space Weather).

What can we learn from studying magnetospheres?
A planet's magnetosphere can give us vital information on the planet's interior and enable us to study different physical and chemical processes that cannot be found or replicated on Earth. In particular we can gain insight into the inter-relationship between plasmas and magnetic fields. For example, a major part of the plasma in Jupiter's magnetosphere comes from the moon Io and forms a doughnut-shape region around the planet. This plasma torus, and the rapid rotation of Jupiter itself, gives the magnetosphere a very different structure to that at Earth. Studies of the different plasma and magnetic structures in planetary magnetospheres help us to understand the complicated plasma and magnetic field phenomenon in distant stars, nebula and galaxies, and provide insight into fundamental plasma physics.

Some planets and moons can be considered to be similar to the Earth at different geological times and studying them provides vital windows into our own planet's past and future, and how humans are affecting it.

How is the UK involved in planetary explorations?
The UK is strongly involved in a number of international space missions. Three current missions with significant UK involvement are:

Cassini-Huygens mission to Saturn
This mission is a collaboration between NASA, ESA and the Italian space agency. The UK designed and built the electron spectrometer and plays a leading role in both plasma and magnetometer instruments. Since 2004 Cassini has discovered that Saturn's moon Enceladus has evidence of liquid water beneath its surface and jets on the surface that spew out ice crystals. Water from the jets influences Saturn's magnetosphere. Saturn's moon Titan has vast methane lakes and hydrocarbon sand dunes. Scientist believe that Titan allows a glimpse of what Earth might have been like in the distant past.

Mars Express
This ESA mission has been in orbit around Mars since 2003. The UK, funded through STFC, has been involved in three of the seven instruments onboard. Research highlights include observations of particles escaping from Mars's atmosphere by the ASPERA-3 instrument, which was built with strong UK involvement. The spacecraft also carried the first ever radar sounding instrument to Mars, both probing beneath Mars's surface and measuring the magnetic field.

Venus Express
In the past Earth's nearest neighbour has been difficult to study due to its runaway greenhouse effect. Since 2006 this ESA mission has discovered strong evidence that the solar wind has stripped away water from Venus's atmosphere, as well as information on trace gases and winds. The UK has been significantly involved with three of the seven instruments onboard.

FACTFILE

- Jupiter's magnetosphere is a giant structure that could easily accommodate the Sun. If it was visible to the naked eye it would be larger than the full moon in the night sky.
- Mercury has the smallest magnetosphere, it is only slightly larger than the planet itself.
- Most planets have magnetic fields that that point roughly along their rotation axis, however Uranus's magnetic field is tilted at almost 60° from its rotation axis.

Banner Image: Artist's concept of particle populations in Saturn's magnetosphere [image: NASA/JPL/JHUAPL]