

7 LORD OF THE RINGS and URANUS & NEPTUNE

SYNOPSIS

LORD OF THE RINGS – Saturn

Saturn, second largest of the gas giants, rules a dazzling domain. The rings of Saturn are billions of moonlets - from grains of dust to rocks the size of trucks. The planet is so light it would float in water. Titan, Saturn's greatest moon, is bigger than the planet Mercury. Shrouded in cloud, Titan resembles early Earth in deep-freeze. To check it out, a spaceprobe has landed on Titan.

URANUS & NEPTUNE– Outer Gas Giants

In the cold and dark outer reaches, the gas giants Uranus and Neptune orbit the distant Sun. Uranus is twice as far from the Sun as Saturn. Neptune is so distant it takes 165 years to orbit the Sun. Uranus rotates on its side - possibly knocked over in a collision that may also have shattered and re-assembled the craggy moon Miranda. Neptune is very windy. Its only large moon, Triton, is the coldest place in the Solar System where dusty gas plumes spurt like oil wells.

BACKGROUND

Second largest planet and sixth from the Sun, Saturn's diameter is 120,000 kilometres, the width of nine Earths. Our planet would fit inside 752 times, far fewer than into Jupiter. Saturn takes 30 years to orbit the Sun and has a tilt of 27 degrees.

Saturn, with just seven-tenths the density of water, would float! Like Jupiter, Saturn is a gas giant with no solid surface – just weather bands. White is high cloud, yellow is lower cloud. The planet is 94 per cent hydrogen, the rest mainly helium. The cloud layers are also like Jupiter's.

Topmost is a diffuse and hazy stratosphere. Beneath is ammonia ice crystals, then ammonium hydrosulphide, ice crystals of water and finally droplets of water. The deeper into Saturn, the hotter and denser it gets. At over 1,000 kilometres in, hydrogen turns liquid. Beyond 25,000 kilometres, it is metallic. The rocky core is 15,000 degrees Celsius.

The magnetic field is probably due to electrical currents in the liquid metallic hydrogen. One result is aurorae around the poles as the magnetic field traps electrically-charged particles from the solar wind. The particles are drawn downward by force lines to react with the atmosphere – particles that have travelled ten times farther than Earth is from the Sun.

The magnificent rings make Saturn so special. Less than half a kilometre thick and half-a-million wide, they are billions of moonlets – from grains of dust to rocks the

size of trucks. So close are the rings to Saturn that its gravitational tug prevents them forming one big moon.

The rings may be the debris of a moon that came too close – or of moons collided. Either way, eventually, they will fall into the planet.

Saturn has nearly 50 moons and the list keeps growing. In a class of its own is Titan, Saturn's only big moon. Larger than Mercury, Titan's dense atmosphere shrouds the surface. But the haze has been penetrated in near infra-red by the Hubble Space Telescope. It revealed two distinct surfaces that may well correspond to land and ocean.

More recently – and since SPACEFILES was made – the Huygens spacecraft has made a soft landing. Still unproven, Titan may have seas of liquid hydrocarbons and tar-coated rocks. The atmosphere, however, is known to be rich in nitrogen, like Earth's but ten times denser – a choking smog as sunlight breaks down methane. Such breakdown can produce organic molecules. The question is: do they form long-chain proteins with a potential for life? Is Titan early Earth in deep-freeze?

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In the cold and dark outer reaches, Uranus is twice as far from the Sun as Saturn – 2.8 billion kilometres. The planet is so distant, it takes more than 84 years to orbit the Sun. Uranus is the third largest gas giant and Earth would fit inside 64 times. Uranus spins backwards and has a crazy tilt of 98 degrees.

Bland-looking Uranus nevertheless has active weather, an atmosphere, cloud layers and a slushy interior not unlike Jupiter and Saturn. But oddly for a gas giant, the core is not very hot. Even stranger is the off-centre magnetic field – due, probably, to force lines springing not from the core, but from overlaying slush.

Tipped sideways, one theory is that Uranus was hit by a body the size of Earth. Another impact may have shattered the moon Miranda. Debris possibly formed the rings around Uranus – more modest than Saturn's – but most of the blasted moon could well have re-assembled and account for the chaotic contours of Miranda today.

Just 480 kilometres wide, Miranda is a geological wonder structured like the roughest rough diamond. At its biggest rift, cliffs rise 15 kilometres. To fall off, in Miranda's weak gravity, it would take 14 minutes to hit the ground beneath. Uranus has four more large moons – Ariel, Umbriel, Titania and the outermost Oberon.

Trouble predicting the position of Uranus led to the discovery of Neptune. Uranus was rarely where astronomers predicted. The reason, they found out, was that Uranus gained speed as it caught up with Neptune on its more distant orbit. After overtaking Neptune, Uranus slowed down. That was it! The pull of Neptune was perturbing the orbit of Uranus. By taking these disturbances into account, astronomers discovered Neptune!

Neptune is so remote that its "year", its solar orbit, lasts 165 years. Slightly smaller than Uranus, Neptune is the farthest gas giant. Neptune tilts at 30 degrees. After the

haze of Uranus, Neptune shows distinct features – lively storms and cirrus clouds streaked in bands across the upper atmosphere. Neptune is very windy.

The atmosphere and interior are typical of a gas giant. But the core radiates more heat than Neptune receives from the Sun. Neptune has the weirdest magnetic field. Tilted at 47 degrees, the axis is closer to the surface than to the core. And, like all gas giants, the force lines have an opposite polarity to Earth's.

Several rings surround Neptune. The outermost varies in thickness. In places material has clumped to form arcs. Neptune has more than a dozen tiny moons and a single big moon, Triton. At minus 235 degrees Celsius, Triton is the coldest place known. The little heat that is not reflected from its icy surface, melts nitrogen beneath the surface. As a result, gas bursts through and is carried far downwind high in the wispy atmosphere.

We are 4.5-billion kilometres from the Sun.

Weblinks for LORD OF THE RINGS - Saturn

<http://en.wikipedia.org/wiki/Saturn> - From Wikipedia, the free encyclopedia, a helpful introduction to Saturn, its physical characteristics and rotation, the rings and moons, with an overview of the exploration of the planet by spacecraft.

http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level1/saturn.html - From the "StarChild" service at NASA's Goddard Space Flight Center, an introduction to Saturn written for young people. Information available at two levels.

<http://www.kidsastronomy.com/saturn.htm> - A simple guide to Saturn for young people.

<http://www.dustbunny.com/afk/planets/saturn/> - From the "Astronomy for Kids" website, a handy summary of Saturn.

http://www.esa.int/esaKIDSen/SEM1U8WJD1E_OurUniverse_0.html - From the European Space Agency's Kids website, an accessible summary of Saturn, its rings and moons for young people.

<http://www.windows.ucar.edu/tour/link=/saturn/saturn.html&edu=high> - From the University Corporation for Atmospheric Research's "Windows to the Universe" website, a comprehensive guide to Saturn, its rings and moons, with information available at beginner, intermediate and advanced levels.

http://www.planetary.org/explore/topics/our_solar_system/saturn/ - From the Planetary Society, a helpful guide to many aspects of Saturn.

<http://voyager.jpl.nasa.gov/> - From NASA's Jet Propulsion Laboratory, a complete guide to the Voyager spacecraft missions to the outer planets and beyond, including Saturn.

<http://hubblesite.org/newscenter/newsdesk/archive/releases/category/solar%20system/saturn/> - A selection of observations of Saturn by the Hubble Space Telescope.

<http://saturn.jpl.nasa.gov/home/index.cfm> - From NASA's Jet Propulsion laboratory, the definitive website for the Cassini-Huygens mission to Saturn, its rings, minor satellites and Titan.

<http://photojournal.jpl.nasa.gov/targetFamily/Saturn> - NASA's image access page for a wide range of images of Saturn, its rings and satellites.

<http://pds-rings.seti.org/saturn/> - From the Rings Node of NASA's Planetary Data System, a set of links relating to Saturn's rings and observations of them.

Weblinks for URANUS + NEPTUNE

<http://voyager.jpl.nasa.gov/> - From NASA's Jet Propulsion Laboratory, a complete guide to the Voyager spacecraft missions to the outer planets and beyond, including Uranus and Neptune.

[http://en.wikipedia.org/wiki/Uranus_\(planet\)](http://en.wikipedia.org/wiki/Uranus_(planet)) - From Wikipedia, the free encyclopedia, a helpful introduction to Uranus, its internal composition, axial tilt, magnetic field, rings and moons.

http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level1/uranus.html - From the "StarChild" service at NASA's Goddard Space Flight Center, an introduction to Uranus written for young people. Information available at two levels.

<http://www.kidsastronomy.com/uranus.htm> - A simple guide to Uranus for young people.

<http://dustbunny.com/afk/planets/uranus/> - From the "Astronomy for Kids" website, a handy summary of Uranus.

http://www.planetary.org/explore/topics/our_solar_system/uranus/ - From the Planetary Society, a helpful guide to many aspects of Uranus.

<http://www.windows.ucar.edu/tour/link=/uranus/uranus.html&edu=high> - From the University Corporation for Atmospheric Research's "Windows to the Universe" website, a comprehensive guide to Uranus and its moons, with information available at beginner, intermediate and advanced levels.

<http://www.nmm.ac.uk/server/show/conWebDoc.287> - From the Royal Observatory Greenwich, England, a good summary of Uranus including the discovery of the planet.

<http://hubblesite.org/newscenter/newsdesk/archive/releases/category/solar%20system/uranus/> - A selection of observations of Uranus by the Hubble Space Telescope.

<http://photojournal.jpl.nasa.gov/targetFamily/Uranus> - NASA's image access page for a wide range of images of Uranus, its rings and satellites.

<http://pds-rings.seti.org/uranus/> - From the Rings Node of NASA's Planetary Data System, a set of links relating to the rings of Uranus and observations of them.

[http://en.wikipedia.org/wiki/Neptune_\(planet\)](http://en.wikipedia.org/wiki/Neptune_(planet)) - From Wikipedia, the free encyclopedia, a helpful introduction to Neptune, its discovery, physical characteristics, atmosphere, rings and moons.

http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level1/neptune.html - From the "StarChild" service at NASA's Goddard Space Flight Center, an introduction to Neptune written for young people. Information available at two levels.

<http://www.kidsastronomy.com/neptune.htm> - A simple guide to Neptune for young people.

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http://www.planetary.org/explore/topics/our_solar_system/neptune/ - From the Planetary Society, a helpful guide to many aspects of Neptune.

<http://www.windows.ucar.edu/tour/link=/neptune/neptune.html&edu=high> - From the University Corporation for Atmospheric Research's "Windows to the Universe" website, a comprehensive guide to Neptune and its moons, with information available at beginner, intermediate and advanced levels.

<http://www.nmm.ac.uk/server/show/conWebDoc.288> - From the Royal Observatory Greenwich, England, a useful summary of Neptune including the discovery of the planet.

<http://hubblesite.org/newscenter/newsdesk/archive/releases/category/solar%20system/neptune/> - A selection of observations of Neptune by the Hubble Space Telescope.

<http://photojournal.jpl.nasa.gov/targetFamily/Neptune> - NASA's image access page for a wide range of images of Neptune, its rings and satellites.

<http://pds-rings.seti.org/neptune/> - From the Rings Node of NASA's Planetary Data System, a useful set of links relating to Neptune's rings and observations of them.