2 MOON and JAWDROP

SYNOPSIS

MOON - Our Partner in Space
The Moon was probably formed when a body the size of Mars collided twice with early Earth. The first collision was a glancing blow. The second, two days later, was a major impact that threw enough material into orbit to form the Moon. Since then, the Moon has been steadily receding. Eventually it will be so distant that Earth will start to wobble and our climate, deprived of its lunar regulator, will become chaotic. The Moon – cratered, airless and inert - is nevertheless our vital partner in space.

JAW-DROP - Eclipses and Aurorae
A total eclipse of the Sun is the greatest spectacular in the Solar System. It happens when the Moon, which is 400 times smaller than the Sun, completely obscures the Sun, which is 400 times farther from us than the Moon – an astonishing celestial coincidence. Nature has another light show – the aurora. A swirling kaleidoscope of colour, it is seen at night around the polar regions when electrified particles from the solar wind interact with Earth's upper atmosphere.

BACKGROUND

When Earth was just 50 million years old, it was probably struck by a body the size of Mars. It was a glancing blow, but two days later the impactor returned. This "double-whammy" most likely threw enough material into orbit to form the Moon. Within a year or two a molten Moon was orbiting a molten Earth.

The Moon was so close to Earth – 20 times nearer than today – that the Moon's orbit was "captured". This locked the Moon into turning once on its axis during each orbit of Earth. The result is that the Moon always presents the same face to Earth. We never see the far side of the Moon.

At a distance of some 384-thousand kilometres, the Moon takes 27-and-one-third days to orbit Earth. As it does so, the Moon appears to change shape – the lunar phases. The Moon has no light of its own. It shines because it is lit by the Sun. As the Moon orbits Earth we see varying amounts of the half that is lit by the Sun and this causes the lunar phases. At full moon we see the entire half that is lit. At new moon, when the Moon is normally invisible from Earth, the half that is lit is turned away from us.

The Moon's diameter, at 3,500-kilometres, is one quarter that of Earth and gravity is one-sixth. By day, temperatures can reach 120 degrees Celsius. At night, they can plunge to minus 160. The Moon is airless, lifeless and barren.

Testimony to billions of years of cosmic bombardment, craters are everywhere. The largest are "seas" or mare regions gouged by gigantic impacts. Lava, welling from beneath, filled these mares and cooled into vast dark patches visible by naked eye from Earth. No wind or rain erodes them.

"Magnificent desolation", is how one astronaut described the Moon. In several missions over 30 years ago, 12 astronauts landed on the Moon. They retrieved geological samples similar to rocks in Earth's upper mantle – proof of a common heritage. The lunar interior is probably solid, its core metallic.

Each year the Moon recedes from Earth by four centimetres. The cause is tidal drag – the gravitational pull exerted by the Moon on our oceans, the same pull which raises the twice-daily tides. Tidal drag is gradually slowing the spin of Earth. Our day is getting longer as Moon and Earth pull farther and farther apart.

Eventually, billions of years hence, the Moon will be too far away to keep Earth on an even keel. With lunar gravity no longer pulling on the bulge at Earth's equator, axial stability will be gone. Earth will start to wobble tilting from zero to 85 degrees. Our climate will be shot.

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The Moon may be receding from Earth but right now the intervening distance provides a glorious celestial coincidence – the phenomenon of a total eclipse of the Sun. It happens about 70 times a century when the Moon completely obscures the solar disc. That is because the Moon is 400 times smaller than the Sun, while the Moon is 400 times closer to us than is the Sun.

A total eclipse is magical. First there is a partial phase lasting up to 90 minutes when observers must use safety glasses as the Moon creeps across the solar face. Then, at totality – lasting smetimes up to seven and a half minutes – eye protectors can be shed. The magnificent corona, the normally invisible outer solar atmosphere, dances like a vast halo in the Sun's magnetic field. Plumes and prominences reach into space.

On Earth, light levels plunge a million-fold. Birds roost, flowers close and dogs bark. Then, as totality ends, sunlight twinkles through the mountains of the Moon, the so-called Baily's Beads, before bursting forth as the Diamond Ring. Once experienced no one forgets a total eclipse of the Sun.

A more common eclipse is a lunar eclipse. It occurs when Earth directly aligns between the Sun and the Moon. As the Moon moves into Earth's shadow, our atmosphere bends and filters sunlight to project a reddish blush on the Moon. A lunar eclipse is visible all over the dark side of Earth.

Nature has another light show – the aurora. Swirling at night time in the upper atmosphere of the polar regions, the aurora borealis of the northern hemisphere and the aurora australis of the southern hemisphere are jaw-dropping displays of colour and light. The cause is 150 million kilometres away – the Sun.

Along with light, heat, energy and other radiation, the Sun emits a solar wind. Whirled outward by the magnetic field, the wind blows at up to 400 kilometres a second – a continuous flow of tenuous gas and electrically-charged particles. On reaching Earth, they are obstructed and must flow around our magnetic field. But

some get through and spiral down force lines toward the polar regions. The result is aurorae – the light of countless collisions between solar and atmospheric particles.

Occasionally, the Sun throws a tantrum called a coronal mass ejection. The solar wind may accelerate to one thousand kilometres a second. The shockwave buffets Earth's magnetic field, the magnetosphere, and we get geomagnetic storms and spectacular auroral displays. The downside is satellites sent haywire and power lines knocked out.

Weblinks for MOON – Our Partner in Space

http://teacher.scholastic.com/researchtools/articlearchives/space/moon.htm - Answers some of the most common questions young people ask about the Moon. Written by an astronomer.

http://coolcosmos.ipac.caltech.edu//cosmic_kids/AskKids/moon.shtml - More answers to common questions about the Moon, written by an astronomer. What is a blue moon? When did astronauts drive lunar rovers on the Moon? How many pounds of moon-rocks were brought back to Earth?

http://en.wikipedia.org/wiki/Moon - From Wikipedia, the free encyclopedia, detailed information about Earth's nearest neighbour in space.

http://www.pa.msu.edu/people/frenchj/moon/index.html - John French's most useful project shows a picture of the Moon for each night during the cycle of the lunar phases - from new moon to new moon.

http://www.lunarrepublic.com/atlas/index.shtml - Click here to visit the Moon! The Lunar Navigator Interactive Maps of the Moon. A complete series of interactive lunar maps, with more than 2,500 formations (including craters, mountains, lakes, seas and valleys) identified simply by moving your mouse cursor over the feature.

http://www.hq.nasa.gov/office/pao/History/alsj/picture.html - The Apollo Lunar Surface Journal's galleries containing all the images taken on the lunar surface by the astronauts, together with pictures from pre-flight training and pictures of equipment and the flight hardware.

http://www.badastronomy.com/bad/misc/apollohoax.html - Astronomer Phil Plait's thorough debunking of the claims that NASA never sent men to the Moon, with links to other sites which also dismiss this notion.

http://moon.google.com/ - Zoom right in to the Apollo landing locations on the Moon. Based on real NASA imagery, this site is an extension of Google Maps and Google Earth.

http://spaceplace.nasa.gov/en/kids/ - A general NASA site for grade school children that demonstrates and explains scientific concepts related to astronomy in a fun, hands-on manner!

Weblinks for JAW-DROP – Eclipses and Aurorae

http://www.mreclipse.com/Special/SEprimer.html - Eclipse guru Fred Espenak's own website packed with useful, easy-to-understand background information about the Sun, Moon and eclipses of the Sun and Moon.

http://en.wikipedia.org/wiki/Eclipses - From Wikipedia, the free encyclopedia, detailed information about eclipses of the Sun and Moon and how they occur.

http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html - NASA's eclipse home page, containing everything you want to know about eclipses of the Sun and of the Moon. Details of past, present and future eclipses. Includes predictions and maps for future eclipses.

http://www.mreclipse.com/Special/photo.html - A sub-section of Fred Espenak's website containing a gallery of beautiful and stunning photographs of eclipses and other celestial phenomena.

http://www.spaceweather.com/ - Forecasts of solar flares and geomagnetic storms, plus daily animations of the Sun, with helpful links to many other related websites.

http://www.spaceweather.com/aurora/gallery.html - The Aurora Galleries contain amazing photographs of the aurora borealis submitted by photographers from many different countries.

http://www.geo.mtu.edu/weather/aurora/images/aurora/jan.curtis/ - An incredible selection of beautiful photographs of the diverse forms of the aurora borealis as captured near Fairbanks, Alaska, by Jan Curtis.

http://www.sec.noaa.gov/ - From the National Weather Service's Space Environment Center, real-time data from the Sun, solar wind, magnetosphere, ionosphere, and links to predictions, educational and classroom materials.

http://www.spaceweathercenter.org/index.html - Useful information about the Sun, plasmas, aurorae and storms in space, plus valuable links for teachers to resources, games, activities and e-cards.