Why is the aurora important?

The aurora is the only visible evidence that the Sun and the Earth are a system connected by more than sunlight.

The Sun's corona continuously emits a solar wind, a stream of electrically charged particles (mostly protons and electrons) flowing out in all directions. These particles interact with Earth's magnetic field (right side of figure), which reaches far into space. Most of the particles from the Sun are deflected by the magnetic field, creating a huge cavity in the solar wind. This cavity is called the magnetosphere, and it stretches about 60,000 kilometers on the day side (toward the Sun) and several hundred thousand kilometers in a long tail on the night side.

Steele Hill

Under certain conditions more of the energy carried by the solar wind can enter the magnetosphere. Here the energy is converted into electric currents and electromagnetic energy and temporarily stored.

This higher energy state of the magnetosphere is unstable and the energy of the currents can be released suddenly. Some of this energy accelerates electrons in the magnetosphere and causes them to spiral down the Earth's magnetic field into the atmosphere, where they produce the aurora. By studying the patterns of auroral light, scientists can obtain a picture of what is happening in the huge magnetosphere.

Do other planets have auroras?

Auroras have been observed on Saturn (image), Jupiter, and Uranus. Any planet with a magnetic field and an atmosphere should likely have auroras.

J.T. Trauger (JPL) and NASA

Popular myths about the aurora

The following are common misconceptions about the aurora:

- Auroras are caused by sunlight reflecting off of the polar ice cap.
- Auroras are caused by moonlight reflecting off of ice crystals in the atmosphere.
- Auroras are caused by electrons arriving directly from the Sun and guided by Earth's magnetic field into the polar atmosphere.

In any of these cases, the aurora would look very different from the beautiful displays we see.

About Polar

NASA's Polar spacecraft was launched on February 24, 1996, to obtain data from the regions over the poles of the Earth. From an orbit that carries it over both poles at least once a day, the spacecraft gathers images of the aurora and studies Earth's interaction with the solar wind, as well as the physical processes that transfer particles and energy into and through the magnetosphere. http://istp.gsfc.nasa.gov/istp/polar

For more information:

Web sources:

The Exploration of the Earth's Magnetosphere
http://www.phy6.org/Education/Intro.html

The Aurora Explained
http://www.alaskascience.com/aurora.htm

Windows to the Universe
http://www.windows.ucar.edu/spaceweather/

Mission to Geospace
http://istp.gsfc.nasa.gov/istp/outreach

Print sources:

Asgeir Brekke and Alv Egeland. *The Northern Light: From Mythology to Space Research.* New York: Springer-Verlag, 1983.

Michael Carlowicz and Ramon Lopez. *Storms from the Sun - The Emerging Science of Space Weather.* Washington, DC: The Joseph Henry Press, 2002.

Robert Eather. *Majestic Lights: The Aurora in Science, History, and the Arts.* Washington, DC: AGU, 1980.

Sten Odenwald. *The 23rd Cycle - Learning to Live with a Stormy Star.* New York: Columbia University Press, 2000.

Kenny Taylor. *Auroras, Earth's Grand Show of Lights.* National Geographic, 200(5), 2001.

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What Causes the Northern Lights?

and other information about the aurora borealis

NASA

National Aeronautics and Space Administration

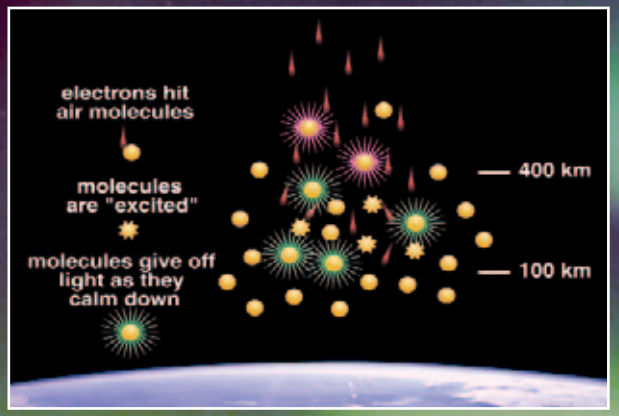
Goddard Space Flight Center
Greenbelt, Maryland 20771

Polar Mission, Mail Code 696

Michel Tournay

What causes the aurora?

The typical "northern lights," or aurora borealis, are caused by collisions between fast-moving electrons and the oxygen and nitrogen in Earth's upper atmosphere. The electrons - which come from the magnetosphere, the region of space controlled by Earth's magnetic field - transfer energy to the oxygen and nitrogen gases, making them "excited." As they "calm down" and return to their normal state, they emit photons, small bursts of energy in the form of light.

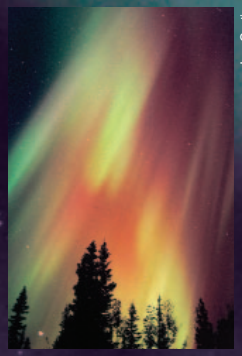


When a large number of these collisions occur, the oxygen and nitrogen can emit enough light for the eye to detect. This ghostly light will produce the dance of colors in the night sky we call the aurora. Most of the light comes from altitudes between 60 and 200 miles. Since the aurora is much dimmer than sunlight, it cannot be seen from the ground in the daytime.

Why the different colors?

Jan Curtis

The color of the aurora depends on which gas - oxygen or nitrogen - is being excited by the electrons, and on how excited it becomes. Oxygen emits either a greenish-yellow light (the most familiar color of the aurora) or a red light; nitrogen generally gives off a blue light. The blending of these colors can also produce purples, pinks, and white. The oxygen and nitrogen also emit ultraviolet light, which can be detected by special cameras on satellites but not by the human eye.



Jan Curtis

Why the different shapes?

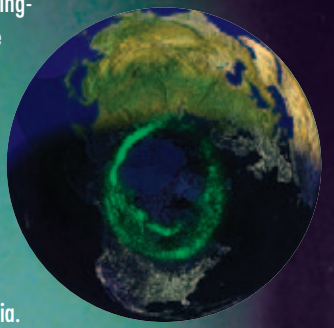
Scientists are still trying to answer this question. The shape of the aurora depends on the source of the electrons in the magnetosphere and on the processes that cause the electrons to precipitate into the atmosphere. Dramatically different shapes can be seen over the course of a single night.

Jan Curtis

Jan Curtis

Jan Curtis

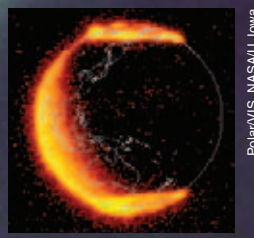
Where can the aurora be seen?



Polar/VIS, NASA/U. Iowa

Auroras usually occur in ring-shaped areas circling the magnetic poles of the Earth. The rings expand and contract with the level of auroral activity. The best places to see auroras are in central Canada, Alaska, and Greenland, northern Scandinavia and northern Russia. On rare occasions, they can be seen as far south as Florida or Texas. An entire ring, called the auroral oval, can only be seen from outer space. This image was taken in ultraviolet light by NASA's Polar satellite and superimposed on a figure of a partly sunlit Earth.

Do auroras exist in the southern hemisphere?



Polar/VIS, NASA/U. Iowa

Yes - an auroral oval also exists around the southern magnetic pole (known as aurora australis). This picture from the Polar spacecraft in ultraviolet light shows the simultaneous "crowns" of the ovals. Simultaneous ovals are nearly mirror images of each other.

Can you hear the aurora?

Observers have speculated about this for hundreds of years, noting that they have heard crackling, swishing, and hissing sounds. But the air where auroras are formed is too thin to even conduct sound, and scientists have been unable to detect any.

Background image: Jan Curtis