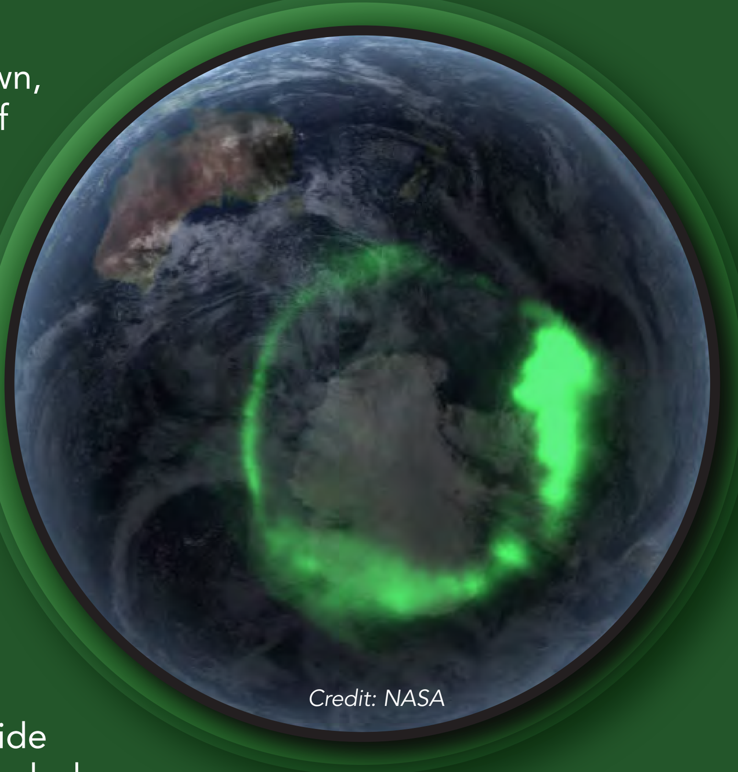
National Aeronautics and Space Administration

EXPLORE AURORAS

On March 17th, 2015, Earth experienced a geomagnetic storm with an aurora that was visible in the Northern U.S. states. This image was captured in Donnelly Creek, Alaska. This aurora might have been caused by the fast solar wind streaming from two solar coronal holes. Image Courtesy of Sebastian Saarloos.

What is the Aurora?



Credit: NASA

Named for the Roman goddess of dawn, the aurora is a captivating display of light in the night sky. The aurora borealis and aurora australis — also called the northern lights and southern lights — occur at the northern and southern poles. Occasionally, space weather interacting with Earth can cause the auroras to extend even further away from the poles. These colorful lights are constantly changing shape and intensity, from dim and scattered to bright enough to read by.

The dancing lights of the aurora provide spectacular views from the ground, and also capture the imaginations of scientists who study incoming energy and particles from the Sun. NASA studies auroras to better understand this complex space environment, which in turn can help us predict and mitigate its effects on communication signals and human technology.

Where Can You See an Aurora?

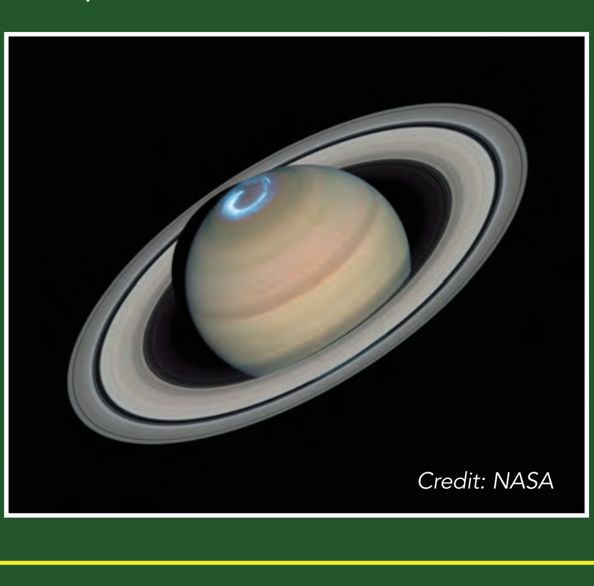
Auroras occur in ring-shaped regions around Earth's magnetic poles in both the northern and southern hemispheres. The northern auroras trace a path across central Alaska, Canada, Greenland, northern Scandinavia, and Russia. The southern auroras appear mostly over the oceans circling Antarctica, but can occasionally reach the far edges of New Zealand, Chile, and Australia. It wasn't until the Space Age, when satellites could gather images of the entire Earth, that scientists were able to see large-scale auroras around both poles at the same time.

A common misconception is that auroras are exclusively seen in cold areas. The truth is that aurora can only be seen by the naked eye where there's little light — and the poles have the longest periods of darkness. Depending on the space weather that occurs during the solar cycle, the visible auroras may not be seen for days or weeks at a time, but during extreme space weather they can be seen in lower, warmer latitudes.

Do Other Planets Have Auroras?

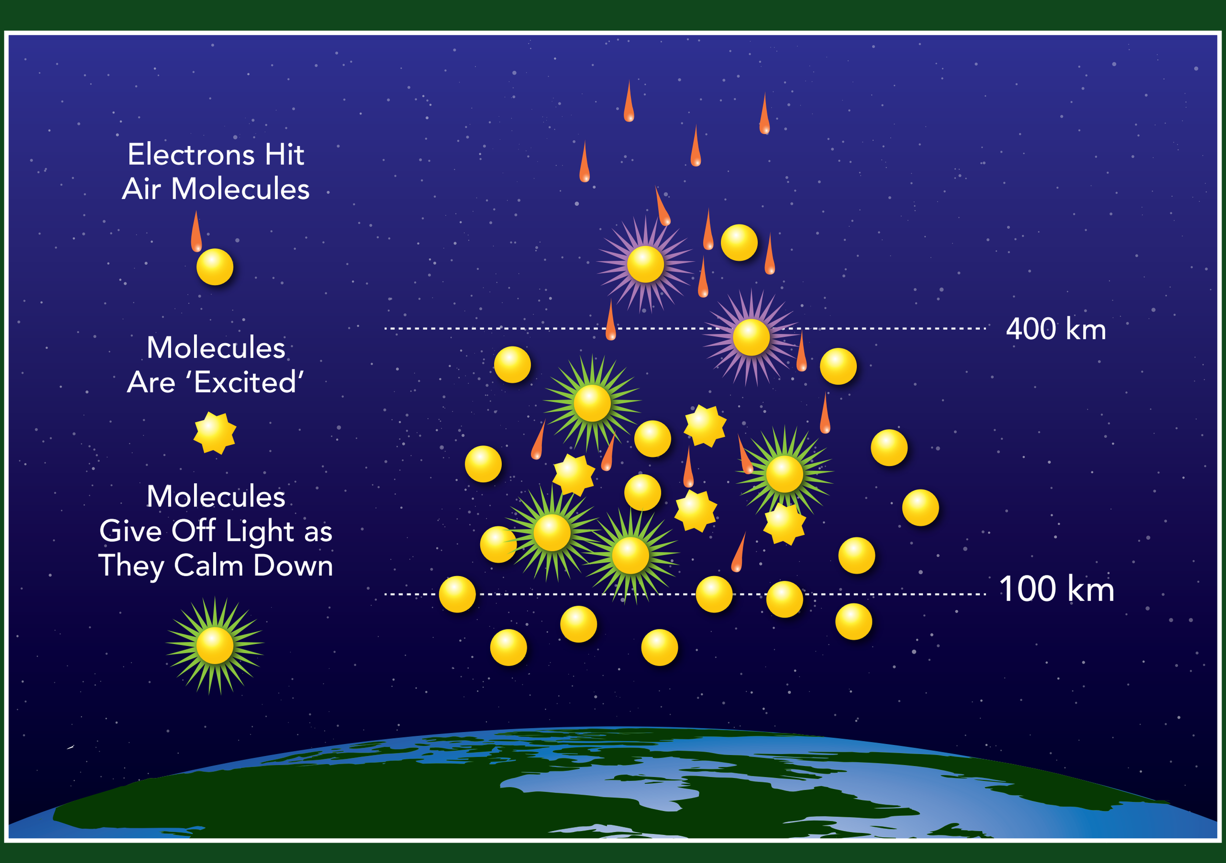
Any planet with a magnetic field and an atmosphere would likely have auroras, and auroras have been observed on planets like Uranus and Saturn.

Credit: NASA



Credit: NASA

What Causes an Aurora?



The Sun continuously produces a solar wind, made of charged particles that flows outward into the solar system. When the solar wind reaches Earth's magnetic field, it can cause magnetic reconnection, an explosive process that allows charged particles from space to accelerate into the atmosphere.

Earth's tear-shaped magnetic field — called the magnetosphere — continuously fluctuates in size and shape. It oscillates and responds to the changing intensity of the solar wind. The solar wind particles funnel around to the long tail of the magnetosphere, where they become trapped. When magnetic reconnection occurs, the particles are accelerated toward Earth's poles. Along the way, particles can collide with atoms and molecules in Earth's upper atmosphere, an interaction that provides the atoms with extra energy which is released as a burst of light. These interactions continue at lower and lower altitudes until all the incoming energy is lost. When we see the glowing aurora, we are watching a billion individual collisions, lighting up the magnetic field lines of Earth.

How Do Scientists Study Auroras?

Scientists study aurora from a variety of vantage points: below, above, and within. From below, ground based telescopes and radar look upward to track what's happening in the sky. From above, NASA's missions investigate what causes auroras to dramatically shift from slowly shimmering waves of light to wildly shifting streaks of color. To gather observations from within an aurora, NASA uses sounding rockets — rockets that take a quick trip through space for 5–20 minutes at a time — to fly right up into auroras as they happen in real time.

Observing auroras — and discovering what causes them to change over time — gives scientists insight on how our planet's magnetosphere reacts to the space weather near Earth.

What Are the Different Types of Auroras?

DISCRETE AURORAS

Discrete auroras are bright thin bands — most common pictures of auroras are of this type. Discrete auroras occur closer to the magnetic poles.

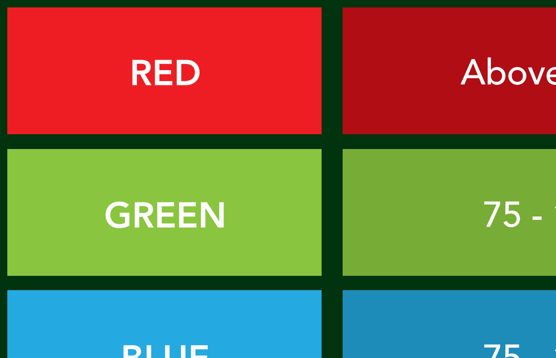
DIFFUSE AURORAS

Diffuse auroras are much more spread out and thin, like a fog. They happen most often further away from Earth's magnetic poles in the lower latitudes. The charged particles are spread out over a large region when they enter the atmosphere, so the aurora is "diffused" and hazy in appearance.

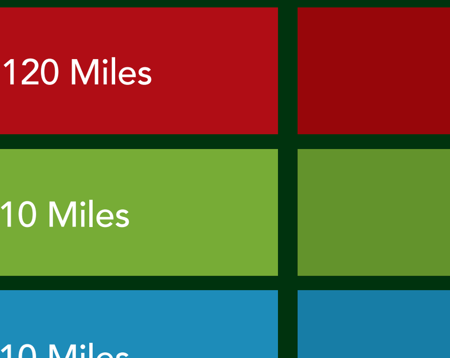
Credit: Jan Curtis

DIFFERENT SHAPES

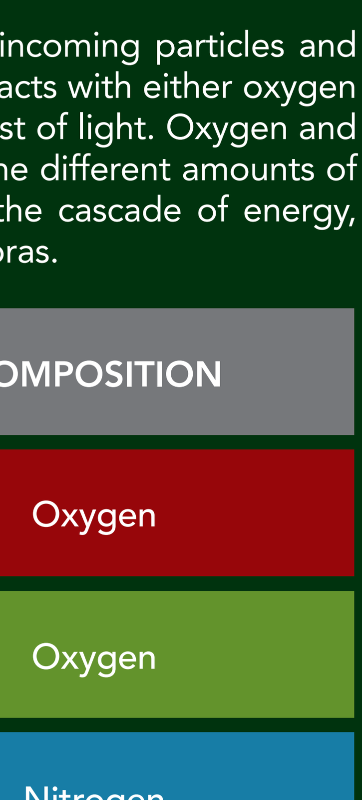
Auroras also come in many different shapes. In fact, dramatically different shapes can be seen over the course of a single night. Scientists are still trying to find out why this happens, but they do know that the shape of the aurora depends on the source of the electrons in the magnetosphere and how the electrons enter the atmosphere.



Credit: Göran Strand



Credit: Jan Curtis



Credit: Jan Curtis

Disclaimer: Auroras do not often appear this bright to the naked eye, but cameras are able to capture even dim auroras in great detail.

DIFFERENT COLORS

The color of an aurora depends on which gas is excited by the incoming particles and where that gas is located in the atmosphere. When a particle interacts with either oxygen or nitrogen, the excess energy from the interaction results in a burst of light. Oxygen and nitrogen can emit green, red, or blue lights. The combination of the different amounts of gases can produce purple, pink, and white lights. All together, the cascade of energy, location, and interactions produce the wonderful colors of the auroras.

PRIMARY COLOR	ALTITUDE	COMPOSITION
RED	Above 120 Miles	Oxygen
GREEN	75 - 110 Miles	Oxygen
BLUE	75 - 110 Miles	Nitrogen
PINK	Below 60 Miles	Nitrogen

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