*Aurora Programs (AP)*
**Funded by the National Aeronautics and Space Administration**
**University of** Alaska **Museum Education**

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# Dynamic Aurora Script

Throughout history, aurora watchers have imagined the source of the northern lights.

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**R09-001**

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The first time you see an aurora display - it takes you by surprise. It is massive and stretches from horizon to horizon. Its shapes and colors shift, sometimes slowly, lazily, at other times with such speed that we remain riveted, following a race across the sky.

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**R09-011**

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The aurora is easy to photograph - requiring only a slow shutter, patience, warm clothes, a wide angle lens, patience, a tripod, and more patience. Video is not so easy without a specifically designed camera.

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**R09-012**

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These are the movements of the aurora as they actually occur. Today, we are still trying to understand the aurora: with eye-witness accounts, cameras, satellites, powerful computers, and rockets.

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**R09-013**

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Scientists once believed that the aurora was caused by sunlight reflecting from ice-crystals, snow, or glaciers in the Arctic. We now know that sunlight, the sun's high-energy radiation, is responsible for photosynthesis, for sunburn, but not for the aurora. The sun is the source of energy for the aurora, but a different kind of energy.

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**R09-014**

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The sun is a giant nuclear furnace slowly converting hydrogen into helium at very high temperatures.

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**R09-015**

The heat created by the sun's core drives its outer atmosphere to expand at great speeds. Intense gravity and magnetic fields restrain much of the expansion, but allow more than a million tons of matter per second to jet outward, towards the planets. This is the birth of the solar wind.

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We watch the sun closely to study its nature and to protect astronauts and spacecraft in orbit, on the moon, or on their way to Mars. We know that every eleven years, the sun grows more active, producing larger than average storms. Such storms would dwarf the Earth were we close enough.

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As it is, the Earth is far enough away. Particles traveling at 2-million miles per hour take two days to reach us – enough time for sun-orbiting satellites to give us a forecast and a warning.

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R09-018

The solar wind blows non-stop, but during storms, the sun bombards the solar system with even more intense streams of energetic matter. Because the sun rotates, the solar wind seems to spiral outward – like a giant lawn-sprinkler.

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The solar wind does not stop at Earth. It travels like ripples on a vast ocean to a distance twice as far as Pluto, a hundred times the distance of the Earth from the sun.

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The particles of the solar wind fill the space that is our solar system, and they cause auroras on other planets besides Earth, planets such as Jupiter, Saturn, and Neptune. Alone, a solar storm is not enough to create an aurora, but with thick atmospheres and strong magnetic fields, these giant planets can exhibit auroras bright enough to see with telescopes.

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**R09-021**

Venus and Mars have atmospheres, however, without planetary magnetic fields, they do not have visible aurora. Earth’s moon has no atmosphere and thus no aurora at all.

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**R09-022**

Clearly, one does not need to travel to Jupiter to witness an aurora. With ample solar wind, a rich atmosphere and a well defined magnetic field, Earth has been a prime location to view the lights for millions of years.

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**R09-023**

All cultures that have set eyes on the aurora have dreamt reasons for its existence. One legend has it, the Aurora steals children that misbehave. Another explains aurora light as exploding swamp gas.

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**R09-024**

The Chipewyan Indians of central Canada believed that the bright Aurora was the appearance of many deer in the sky. When they vigorously stroked the hair of a deer skin in the dark, they saw sparks and believed this to be the aurora.

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****R09-026****

The creation of each auroral spark is a series of stepsTT10 1 Tf10.02 0 0 10.02 108 656.52 Tm357 c5cb7554e5cfa5cf65

**R09-028**

This atom may be struck by an incoming electron from space. This collision stores energy in the atom for a brief period of time. – usually a fraction of a second. When the atom releases the energy, it does so in the form of a photon of light. From the ground, we cannot see the atoms or the storm of electrons, only the tremendous number of photons produced by these collisions. When all the tiny sparks are added together, all across the canvas of our night skies we see the shimmering curtains of the aurora.

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****R09-084****

But the aurora is not just light in the sky; it is a curtain made up of specific colors. To understand why, we need to look at the atmosphere, the canvas, more closely.

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**R09-030**

A neon sign is created when we bombard neon gas with a stream of electrons provided by the power company. The neon gas produces a very particular red-orange color. This color is created from a combination of select colors from the full color spectrum – determined by the properties of the neon atom. Not surprisingly, the colors of the aurora are determined by the gases present in our atmosphere. The aurora appears as specific colors, originating not from neon but from nitrogen and oxygen gas.

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**R09-031**

As a whole, Nitrogen makes up 78% of our atmosphere and oxygen 21%, but the ratio changes with altitude. At the altitude of the aurora, oxygen is dominant.

When visible, the very top of the aurora can appear red – a result of electrons bombarding oxygen gas in a thin atmosphere. Below this, in a thicker atmosphere still dominated by oxygen, the aurora appears green. This green is by far the most commonly seen color of the aurora.

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**R09-032**

At a still lower altitude, the aurora can appear with a stunning pink or magenta lower border from the increased presence of nitrogen gas.

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**R09-033**

The electrons that stream into our atmosphere will penetrate hundreds of miles, but are prevented from penetrating too deeply due to collisions with a thicker and thicker atmosphere, resulting in that lower border still 50 miles above our heads. Electrons do not travel through a thick atmosphere very well. If you've given someone a static shock on a cold, dry day, you know you pretty much have to touch your victim for the electrons to leap across the gap of air.

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From a good vantage point on the ground, the aurora seems pretty close – even close enough to touch perhaps, but this is only an illusion. Scientists have photographed the lights from distant points in Alaska and have calculated their altitude. The aurora is a long way up there. The closest it ever comes is still 50 miles above the ground.

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By comparison, Mount McKinley is rather short – only about 4 miles high. Commercial airplanes fly about 10 miles high – and experimental long-duration balloons only ascend to some 20 miles. The aurora exists between 50 and 400 miles from the ground.

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**R09-036**

The aurora exists at a height that is difficult to study. Scientists photograph and video the lights below from airplanes and on the ground, and from above using satellites. Getting inside the aurora is difficult because airplanes cannot fly this high and satellites cannot fly this low.

**R09-037**

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Down on the surface one can travel too far north to see it well. Fairbanks is just about where we want to be.

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In the daytime, the aurora is out and usually far to the north of Fairbanks. However, as the Earth rotates Fairbanks towards night, or what passes for night in summer, Fairbanks will come under the aurora. The aurora will seem to progress southerly until it is a little south around true midnight, and return to the north before dawn.

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During large solar storms, a more powerful solar

Earth’s magnetic field is very similar. If you were traveling in either direction along a field line you would end up at one of the two poles, not at the middle of the magnet.

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This constantly moving oval is thicker on the night-side of the Earth, but is still visibly quite narrow compared to its height of several hundred miles.

**R09-086**

If you think it is hard to spot the northern lights, trying catching a glimpse of the southern lights.

**R09-059**

These are the southern lights, the Aurora Australis – and the way the photograph is to go.

**R09-060**

We see both polar auroras in this satellite photo. The computer has drawn in Australia, New Zealand, Japan – and the proof that Alaska is not actually next to Hawaii – as some maps indicate.

**R09-061**

These plots show the extent and position of the auroral ovals in the northern and southern hemispheres. Satellites update this information every 10 minutes.

**R09-062**

Note how much farther south the Aurora Australis is compared to Australia and New Zealand. In fact, the only good place to consistently see the Aurora Australis is from – or off the coast of

Because Interior Alaska is an excellent place to view the aurora, scientists study the aurora extensively at the UAF campus, the Toolik Lake field station, and the Poker Flat research range. The University of Alaska is the only American university to own and operate a rocket range. It is about 20 miles northeast of Fairbanks as the raven flies.

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**R09-073**

Not only scientists and casual viewers seek to better understand the aurora. Artists paint, photograph, and animate the lights, documenting its many forms and curious motions. At the

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This is a classic image of the aurora, but not because we can deduce the magnetic field lines as angled rays as they enter the atmosphere – or the fact that the colors of the aurora are clearly layered, red above green above magenta, but because all good photographs should include an aerial or power pole. At least we shouldn't be disappointed when they sneak into our photographs.

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**R09-077**

They are an important reminder that the same solar forces that create the aurora can disrupt our power systems, knock satellites from orbit, affect radio and cell-phone communications, and endanger astronauts.

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**R09-078**

Perhaps some of you noticed in the museum's pipeline exhibit that when the oil pipeline is placed underground its design protects it from the northern lights. The oil pipeline is an 800-mile long wire over which a magnetic field is shifting. The field induces an electrical current, and such a current would corrode the metal of the pipe if simple but importance precautions were not taken.

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**R09-079**

Scientists using satellites continually monitor the sun for eruptions and increased activity. The next solar maximum is approaching in 2012 and with the increased number of sunspots will come larger and larger storms. Already, the sun is a little more agitated than it was last year. Larger and more frequent storms will produce brighter auroras that appear farther south than usual. Keep an eye on the northern night skies and listen for forecasts of unusual space-weather. There are many websites that forecast aurora visibility for your part of the Earth.

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