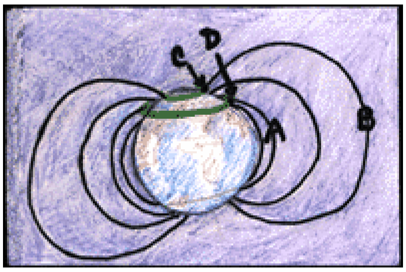
What makes them happen?

Before we can understand how auroras are made, we need to learn a few facts about our Earth and the space around it. There are many things in the space around the Earth that we can't see. Can you think of at least two of them? The first thing is what we need in order to breathe, our atmosphere. Our atmosphere is made up of several layers of gases surrounding the Earth. The outer-most layer is called the ionosphere, and is very important in the study of auroras. The second thing is a giant magnetic field. Our Earth's core is made up of metals which act like a giant magnet stuck in the center of the Earth. This creates a magnetic field around the Earth called the magnetosphere. If you've ever played with a magnet you've seen how a magnetic field can affect certain objects nearby. Our Earth's magnetosphere extends far out into space. This picture shows how the magnetic field generated by the Earth's core is like the field of a bar magnet. Since we can't see the magnetosphere, we draw lines to represent it. Notice that it goes into and out of the Earth at the poles. These are the Earth's magnetic poles. The Earth's magnetic field varies in strength. Where the lines are closest together it is strongest. Where they are furthest apart it is weakest. Look at the picture. Can you tell where the magnetic field is the strongest? Where is it weakest? But the Earth's magnetic field doesn't exist in empty space. The Sun has a magnetic field too. Also, atomic particles are constantly boiling off the Sun and moving outward at very high speeds. Together, the solar magnetic field and streaming particles are called the "solar wind." This wind is always pushing on the Earth's magnetic field, changing its shape. You change the shape of a soap bubble in a similar manner by blowing on its surface. This artist's illustration shows the shape of the Earth's magnetic field in the solar wind. The way the solar wind affects the Earth's magnetoshpere is an important part of what causes auroras. Many things about how auroras happen are still unknown. However, scientists do know a lot about the events that lead to bright auroras. The auroral lights' fuel comes from the particles and energy of the solar wind, which is constantly changing. It takes 3 to 6 days for particles from the Sun to reach Earth. The number of particles and the intensity of the solar wind depends on how active the Sun is. Examples of solar activity include sunspots and solar flares. Because of the connection between solar activity and auroras, the more active the Sun is, the "bigger" the auroral events on Earth will be. Energetic events on the Sun can turn the solar wind into an intense solar "gale" which injects large numbers of energetic particles in the Earth's magnetoshpere. The charged particles travel along the field lines with so much energy that they penetrate the ionosphere, where they hit gas atoms and molecules. These collisions give off energy that we see as colored light. This historical graph shows how the sun and auroras might seem to be related.

Where can you see them?

You'll recall that when solar wind particles are forced towards the Earth's magnetic poles, they travel along the magnetic field lines and may collide with atoms or molecules in the Earth's ionosphere. As particles travel downward the ionosphere gets thicker and the magnetic field lines become closer together. As the particles crowd in towards each pole, there are so many collisions it creates a ring of light. This is why the auroral ring is around the Earth's magnetic poles.

Since auroras are fueled by the solar wind and its particles, the appearance of each aurora depends of the amount of solar activity. Low levels of activity produce weaker, less energetic particles. These particles are easily trapped. They will be captured by the weaker, outer portion of the magnetosphere (point B). Tracing the path of these outer field lines you will see that the particles will produce a small auroral ring near the poles (point C). Note that the diagram only shows the northern ring. There would be a similar ring on the southern side that was omitted for clarity.



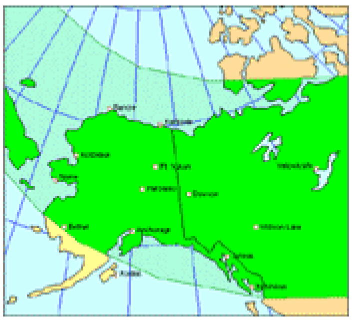
High levels of solar activity tend to release more energetic particles. It takes a strong magnetic field to capture these energetic particles. Since the Earth's magnetic field is stronger at point A (see diagram) than at B, energetic particles will penetrate farther into the magnetic field before they are trapped. If you follow the path that the particles travel from point A, you see that the aurora will occur farther away from the poles (point D). So, where you can go to see an aurora really depends on the amount of recent solar activity. This is one theory associated with the formation of the auroral oval. There are many other kinds of auroras which are caused by particles in other areas of the Earth's magnetic field.

Why are they different colors?

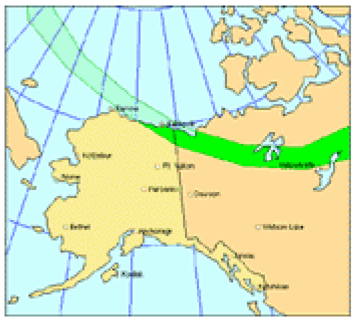
Have you ever noticed the different colors in streetlights? Some are a dark yellow color while others have a blue or purplish light. How about neon signs? They have many different colors. Streetlights and neon signs are filled with gas. When they are plugged in, the energy makes the gas molecules move around and bump into each other. When the molecules collide, energy is given off that you see as light. The color of the light given off depends on the type of gas. Every gas shines its own personal color of light. This color is like a fingerprint because no two gases give off the same color. When you see a dark yellow streetlight it must be filled with sodium gas. Only sodium atoms give off that dark yellow color. The dark orange neon signs are filled with pure neon gas. Other colors of neon signs are actually neon mixed with other types of gases. The unique colors of light produced by a gas are called its "spectrum". Some gases may give off several different colors of light, but that set of colors only occurs in that particular gas.

The auroral lights' colors are determined by the gases in the Earth's atmosphere. In the ionosphere, where the collisions are taking place, incoming solar particles collide with oxygen and nitrogen gases. Oxygen atoms give off green and red light. Nitrogen atoms give off blue light. Other gases also give off light, but it is difficult for our eyes to see it.

Small maps for understand better



More energetic solar particles mean a larger auroral ring that can be seen at lower latitudes.



Less energetic solar particles are easily captured by the Earth's magnetosphere, and are channelled to higher latitudes by magnetic field lines.