

The Aurora Borealis

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Abstract: The Aurora Borealis is a timeless phenomenon that has often baffled those early observers as to their origin. Tribes and cultures all over the world have come up with stories and traditions to try and explain the strange occurrences but modern science has been able to tell us how they really happen. The aurorae generally occur from a reaction of solar particles with the numerous atmospheric gasses in the troposphere of the Earth as well as other planets. When the solar particles collide with atmospheric gasses they excite the particles which emit a glow as they return to ground state. The gas of collision and the height of collision are both factors that determine the color of the aurora, and the pull of the Earth's magnetic field determines where on the Earth's they can be seen.



*The Aurora Borealis as seen in Iceland
Photograph taken by Luka Esenko*

III. INTRODUCTION

The Aurora Borealis is a fascinating spectacle that has been around for as long as the planet has been here, baffling early observers as to what caused such an extravagant display in the atmosphere. They were originally sighted and named the "*Aurora Borealis*" by French scientist Pierre Gassendi in 1621 after Aurora, the Roman goddess of dawn, and Boreas, the Roman god of the north wind.⁷ These dancing lights are also known as the Northern Lights in the northern latitudes and the Aurora Australis or Corona Borealis in the southern latitudes. They are most frequent between September and October and between March and April because of the Earth's tilt in relation to the sun.

There are numerous legends that surround the mystery of the Northern Lights, both good and bad, and they have woven their way into the traditions and beliefs of cultures the world round. In medieval times, it was believed that the appearance of the lights were foreshadowing's and omens of war or famine since the lights rarely ventured into the southern latitudes. The Fox Indians of Wisconsin believed they were the ghosts of enemies past slain who were restless for revenge. The Inuit tribes of Alaska believed the lights were the spirits of the animals they had hunted and others believed they were the spirits of their own people who had died and gone up into the heavens.⁵ Still others saw them as the spirits of children who had died too young, playing in the heavens and dancing with streamers and ribbon.

IV. WHAT ARE THEY AND WHAT CAUSES THEM?

Despite the past mysteries that surround the displays, modern science has been able to explain for us in recent times what the Aurora Borealis' really are and what really causes them. In basic terms, they are a natural phenomenon that often occurs as curtains of light in the upper atmosphere but they can also appear as arcs or spirals. They are generally within 60 to 620 miles

above the Earth's surface. The height at which they occur and the gas with which they are made up of is what produces the different colors they occur in such as green, red, violet, pink, and white. Norwegian scientist Kristian Birkeland, also known as the "father of modern aural science," was the first one who suggested in June of 1896 the theory that the lights were caused by sunspots.⁶

Despite the fact that our sun is so far away, it still has many more effects on the Earth aside from providing us with warmth. The origin of the Northern Lights starts at the sun during solar storms, which generally run on an 11 year cycle. These produce solar flares and solar wind which sends charged particles racing towards our atmosphere, often reaching Earth within two to three days of being blown from the sun's surface.⁶

The Aurora Borealis are caused by an interaction between those charged electrons and elements in the Earth's atmosphere (Figure 1). When electrically charged particles in solar wind strike the Earth's atmosphere, the energy from the collision releases photons that cause the charged particles to glow. Sun spots on the 11 year cycle often become more active during those intervals which is what causes the lights to extend into farther south latitudes on rare occasions⁴

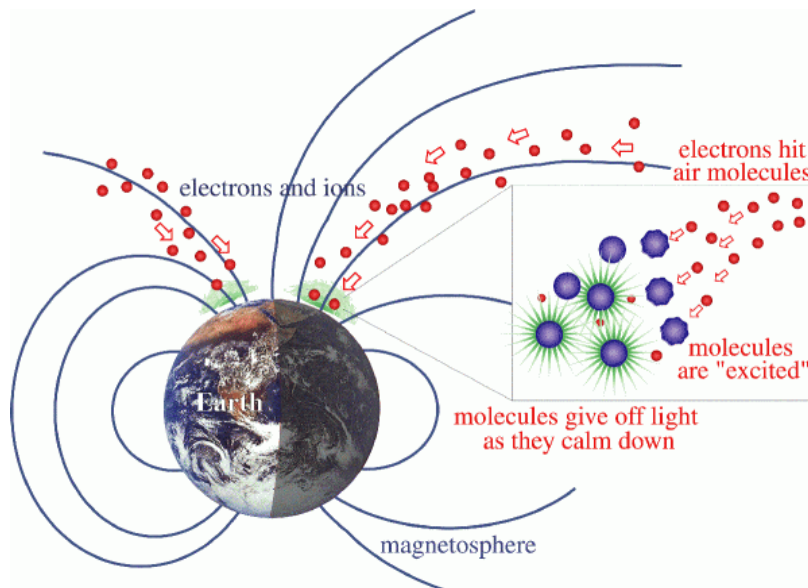


Figure 1: Shows charged particles from the sun striking air molecules in the Earth's magnetic field which causes those atoms to become excited.²

I. WHERE THEY CAN BE SEEN AND WHY

The Aurora Borealis commonly occur in the northern latitudes, but can sometimes venture into the more southern latitudes of the northern hemisphere when the flow of ions from the sun is stronger (like during one of the 11 year solar storm cycles). They can commonly be seen in nations bordering the Arctic Ocean such as Canada, Alaska, Scandinavian countries, Iceland, Greenland, and Russia.

As said earlier, the aurora are caused by particles in solar wind produced by the sun. Another name for this solar wind is the coronal mass ejection, or the CME. When this cloud of gas and particles nears the Earth, it collides with the Earth's magnetic field which flows along its course, centering on the poles of the Earth. The band at which most Aurora occur is also called the "aurora vocals" or "auroral ovals" which center on the magnetic poles. When the solar wind hits the Earth's magnetic field, it is tunneled directly to the poles where it reaches the atmosphere and interacts with oxygen and nitrogen, producing the Aurora Borealis. This is why, in general, the aurorae tend to stay near the poles.

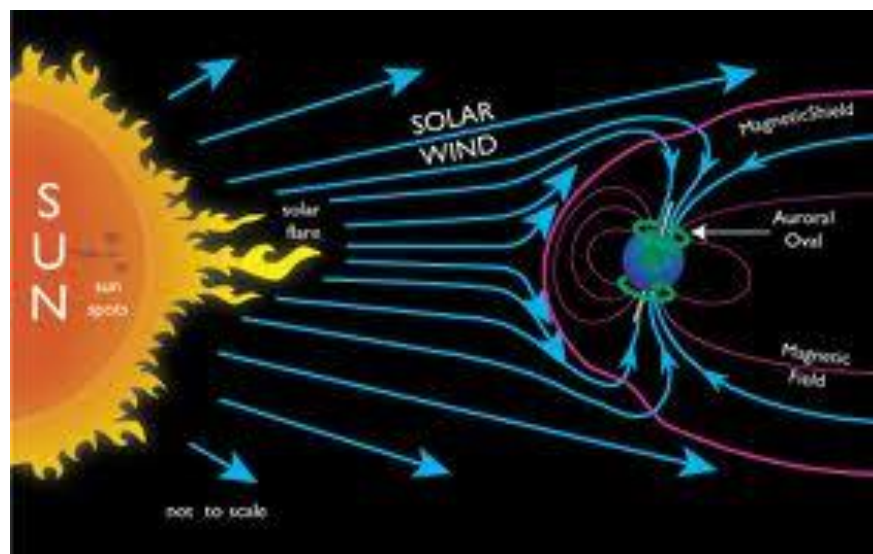


Figure 2: Shows the Earth's magnetic field and the directionality of solar wind once it hits that barrier.

II. THE COLORS OF THE AURORA BOREALIS

The Earth's atmosphere is made up of numerous gasses, the most prominent being nitrogen at 78% and oxygen at 21%. The remaining 1% is a combination of carbon dioxide, argon, water vapor, and an assortment of other miscellaneous gasses. When charged particles from the sun hit particles of these atmospheric gasses, they ionize or excite the gas particles and cause them to glow and their return to ground state is what emits the aurorae.

The green aurorae are produced from a reaction of solar particles with oxygen at altitudes of up to 150 miles and the red are again a reaction with oxygen, but at altitudes higher than 150 miles.⁴ Interestingly enough, even though the red aurorae tend to happen at higher altitudes and closer to the point of impact, they are much more rare than the green aurorae, which are the most common of all the colors. This is because during the oxygen particles return to ground state, it only takes three quarters of a second for it to emit green light whereas it takes almost a full two minutes to emit red light. The farther down in the atmosphere the particles sink, the denser packed it becomes with other particles, and the more the particles collide with other molecules the less it is able to emit. In other words, red emissions can only happen at higher altitudes because as the oxygen particles sink, they have less and less time to emit red light.¹



Picture 1: shows the extremely rare red Aurora Borealis over St. Elias National Park in Alaska. Photo credit to Michael S. Quinton



Picture 2: shows a green Aurora Borealis over Norway. Photo credit to Arild Heitmann

When it comes to the aurorae produced by nitrogen, the blue aurorae, which are very uncommon as well, are a reaction between the sun's particles and nitrogen in altitudes up to 60 miles, and purple or violet are collisions at altitudes above 60 miles.⁴



Picture 3: shows a very uncommon blue Aurora Borealis. Picture credit to <http://southiceland.blogspot.com/>



Picture 2: shows a purple Aurora Borealis. Photo credit to http://www.hdwallpapers.in/purple_aurora_borealis-wallpapers.html

III. CLOSING REMARKS

The Aurora Borealis occurs in so many colors, not only as red, green, blue, and purple, but sometimes as orange, yellow, white or even as combinations of colors like green and pink. The aurorae also appear in different forms ranging from a diffuse glow, to curtains that blanket the skies. Sometimes they quietly ripple and sometimes they stay constantly in motion, changing at impressive speeds. Despite the ever changing face of the Aurora Borealis, they are constantly a spectacular phenomenon that people travel around the world to see. They have even been named one of the seven wonders of the natural world because of their beauty and popularity.

Tribes all over the world still have traditions about them and modern explanations of how they really happen will never really change the traditions that have evolved from their presence

over the millennia. Though we may no longer believe as the early settlers of Greenland did that the oceans are surrounded by fire, and we may know for a fact that the Aboriginal Australians ideas of fire in the sky isn't at all true, but we are still held captive by the breathtaking sight and the intricate connections with forces outside the Earth's atmosphere that the Aurora Borealis shows. They still remain an awe inspiring sight that baffles the young observer when they first lay eyes on the faintly tangible dancing lights. We can still be amazed at the beauty and we may still like to imagine sometimes that there really is a bear or child up there somewhere dancing and playing, painting the skies with ribbons of color.

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