Review Article

The Aurorae

Andrew Watson

St Lawrence College, Kent, UK. Email: andrewwatson96@hotmail.com

ABSTRACT

The Aurora Borealis and Aurora Australis are amongst the world's seven natural wonders and have left men in awe for generations. This article investigates the causes of The Aurorae, the causes of the different colours and investigates Auroras on other planets such as the Jovian Aurora on Jupiter.

The Aurorae

The Aurora Borealis is one of the world's seven natural wonders, and with the exotic array of colours found in it, it isn't at all a wonder why so many people wish to see it.
Both the Aurora Borealis (named by Pierre Gassendi, a French artist, after the Roman goddess of the dawn, Aurora, and the Roman god of the northern wind, Boreas) and the Aurora Australis (named Australis, meaning "Southern") [1] have caught the attention of hundreds of men for hundreds of years, and records dating back from the Vikings (The King's Mirror, written in 1250).
In The King's Mirror, a number of ideas on the formation of the Aurora Borealis, such as "the frost and glaciers have become so powerful there that they are able to radiate forth these flames." [2]
Not only the Vikings had their ideas on the Northern Lights, but also the Romans; Seneca the Younger classified the Northern Lights into a number of different categories depending on how they looked – there was the well (putei), casks (pithaei), chasms (chasmata), bearded (pogoniae) and cypresses (cyparissae). [3]
Much later in history, from 1902 to 1903, a Norwegian scientist by the name of Kristian Birkeland [figure 1] did extraordinary amounts of research into the Aurora Borealis. His theory was that the auroral electrojets (which are found in the auroral ionosphere) [4] were connected to currents named in honour of him (Birkeland currents), that streamed along geomagnetic lines, flowing between the magnetosphere and high latitude ionosphere, away from the polar region of the Arctic.
Birkeland's theory of the auroral electrojets and Birkeland currents were a source of controversy when he was alive and even a number of years after his death. However, his theory was proved in 1967 when the USA sent a probe into space. [5]

Figure 1: A picture of Kristen Birkeland, available at http://upload.wikimedia.org/wikipedia/commons/e/e7/Asta_Norregaard_Kristian_Birkeland_1900.jpg

Actual Causes of the Aurorae

Both of the Aurorae, the Borealis and Australis, are caused by solar particles in the solar wind (numbering in the hundreds of millions) colliding with the atmospheric shielding.
These solar particles, without the atmospheric shielding, would make the Earth an inhospitable place to live. The solar particles are electrically charged when they collide with the

Figure 2: An image of an aurorae: http://en.wikipedia.org/wiki/File:Red_and_green_auroras.jpg

atmospheric shielding surrounding the Earth. The energy resulting from these crashes is released as photons, innumerable particles of light, giving the intense colours of the Aurorae. Seneca the Younger was right when he categorised the aurorae into different groups by how they looked, as they can vary vastly. The shimmering effect in most aurorae is produced by the fading particle explosions at the exact same moment that new collisions and explosions occur.
The colours of the aurorae are caused by two things:

1) The height of the collisions
2) The gases in the atmosphere

The green in the aurorae, the most common of all colours, is caused by low height collisions of the solar particles with oxygen, from heights of one hundred kilometres above the Earth's surface. At greater heights of around 250 kilometres these collisions with oxygen produce red aurorae. [6]
The blues are found at the very bottom of the "aurora zone", at only ninety-six kilometres from the Earth's surface. They are caused by collision of solar particles with nitrogen found in the atmospheric shielding. However, at alternate altitudes nitrogen can also cause some pink and red colours as well. Purple can be seen when really energetic particles pierce deep into the atmospheric shielding about eighty kilometres above the surface of the Earth.
Solar storms can also cause aurorae. This can change the course of the aurorae, shifting them towards the equator due to the magnetic disturbance of the Earth by the sun. [7]

Aurorae Found on Other Planets

Just like aurorae on Earth [figure 2], other planets have their own versions. On Jupiter, the Jovian Aurora is found. These are caused by the same effect as that on Earth, by the solar particles colliding with an atmospheric shield. Even more similar is that Jupiter's aurorae are at its poles, just like that of Earth. Not only Jupiter and Earth have aurorae though. Saturn is another planet that has its own aurorae, caused by the same effect as that on Earth and Jupiter. However, Saturn's aurorae have only recently been found by

camera - the Cassini camera in 2008. Again, like Earth, Saturn's aurorae are at its poles due to the magnetic fields, found on every planet, which force them either northward or southward. [8]

Where to see the Aurorae

The best places to see the Aurora Borealis, the Northern Lights, are in high latitudes of the northern hemisphere, in countries such as Norway and Sweden, and some areas of Russia, such as Siberia. The best time of day to see the aurora is during the night, as long as it's clear.
The Aurora Australis is much harder to see as it's rare to see it outside of Antarctica, though they can be seen in countries such as New Zealand and the southernmost tip of Argentina and Australia. [9]

References:

1. http://en.wikipedia.org/wiki/Aurora_(astronomy)
2. http://www.vikinganswerlady.com/njordrljos.shtml
3. http://en.wikipedia.org/wiki/Aurora_(astronomy)#History_of_aurora_theories
4. http://en.wikipedia.org/wiki/Electrojet#Auroral_Electrojet
5. http://en.wikipedia.org/wiki/Kristian_Birkeland
6. http://www.universetoday.com/42623/aurora-australis/
7. http://news.discovery.com/space/aurora-northern-lights-space-phenomena.html
8. http://news.discovery.com/space/aurora-northern-lights-space-phenomena.html
9. http://odin.gi.alaska.edu/FAQ

About the Author

Andrew Watson is currently doing GCSEs at school and is hoping to go into medicine later in life. After having travelled around for most of his young life, he has settled into school and enjoys sport, including rugby, hockey and running. Also, as an avid fan of the outdoors, Andrew's interest in the Aurorae has made him go to a lot of effort to try and see them, and see them he has, recently, in Iceland.

Call for Submissions, Scientists and Editors

Who are we?

The Young Scientists Journal is an unique online science journal, written by young scientists for young scientists (aged 12-20). More than that, the journal is run entirely by teenagers. It is the only peer review science journal for this age group, and the perfect journal for aspiring scientists, editors, and graphic designers.

Who are you?

Do you enjoy research? Or are you more interested in editing text and graphics? Do you work well in a team? Or perhaps you have the ability to produce papers on interesting topics by the handful? In short, if you have recently done an interesting school project, enjoy pursuing unique research, or have documents written for competitions languishing on your computer, get in touch about having your article published by The Young Scientists Journal! Simply submit your work via the website, and your article will be processed by a team of students and then an International Advisory Board, before being made into an official article with its own unique code. We are also keen to receive shorter review articles, and creative material such as videos or cartoons.
Similarly, if you would be interested in getting more involved in the management of the Journal, let us know! We are actively recruiting students at the moment to our Young Scientists team for tasks such as editing articles, managing the website, graphic design and helping with publicity.

Get Involved!

Involvement with the Young Scientists Journal promises to be rewarding, fun, and will look fantastic on your CV. Get in touch at editor@ysjournal.com