

A Message from Galileo Galilei (1564-1642)



Hi, I am an Italian scientist raised in Pisa during the late Renaissance period. Galileo was my first name. At that time in Italy, "famous" people were called by their first names instead of their family names. People say I laid the foundations of modern science.

Following advice from my father, who was a music and mathematics teacher, I enrolled in a medical course at the University of Pisa. I became, however, totally absorbed in mathematics, instead of medical science. Do you know that the "Isochronism of the Pendulum" principle, which you learn at high school, is one of my findings? Finally I quit the university.

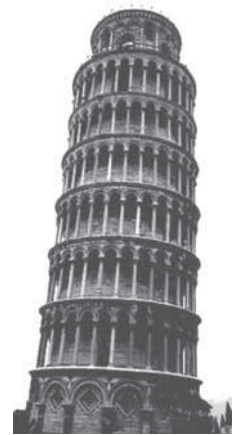
While working as a private teacher to rear my younger brothers and sisters, I kept doing research. At the age of 25, my first paper was published and was well accepted, and I was invited to be a Lecturer at the University of Pisa. My father died 2 years later.

Twenty years before I was born, Copernicus published the Copernican theory that our Earth, not the stars in the sky, is moving. But, people hardly believed this theory because what we see in daily life is that the sun rises from the eastern horizon and goes down in the west.

Among other findings of mine are Jupiter's four satellites, craters on the moon's surface, and waxing and waning of the moon, all from observations with a Galilean telescope. These discoveries cast questions on the astronomy of that time, as proof of the heliocentric theory. My discovery of the sunspots was criticized by the advocates who said "what a shame to insist that there are spots on the perfect sun!" I had to face the Inquisition several times. When Newton, who was born in the year of my death, established the dynamics by combining my findings, I felt my efforts were rewarded.

Because of long-time observations of the sun with the naked eye, my retinas were damaged, and I became blind. My later papers were written by dictation.

To the mysterious glow in the sky I gave the name "aurora" after the Roman goddess of dawn. In 1621, a fabulous aurora showed up in Venice. Even though I had seen auroras several times, that was the one I could never forget. I did not have the slightest idea that the origin of auroras is with the sunspots that I found myself! It was not until 200 years later that people became to know the true scenario for the generation of auroras.



Leaning Tower of Pisa

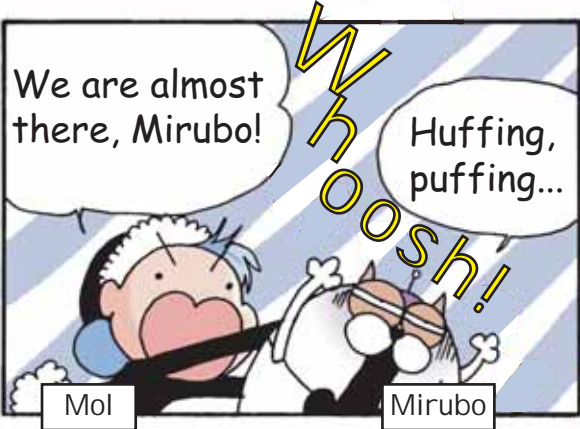


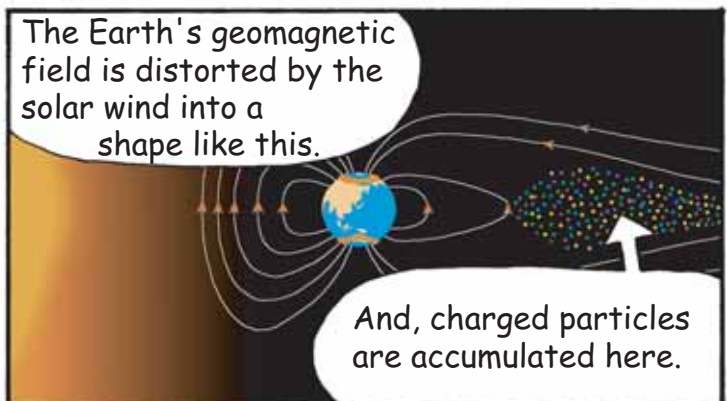
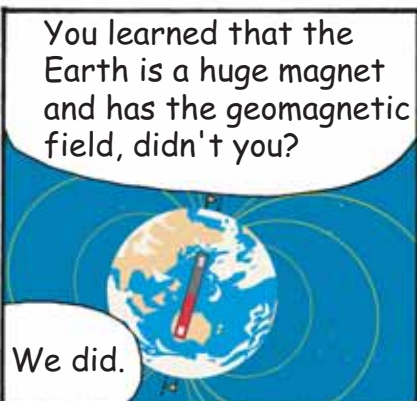
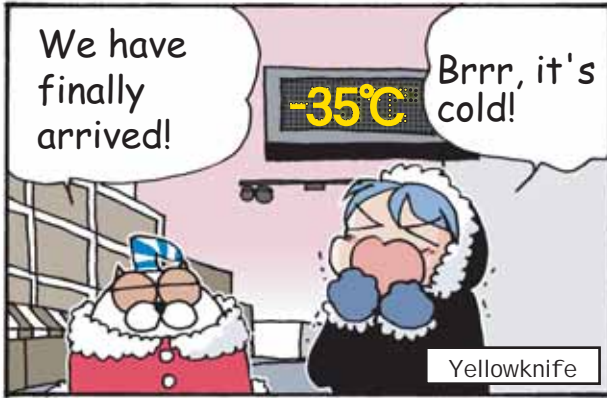
Auroral breakup seen from directly underneath. <Photos by Shiori Uchino>

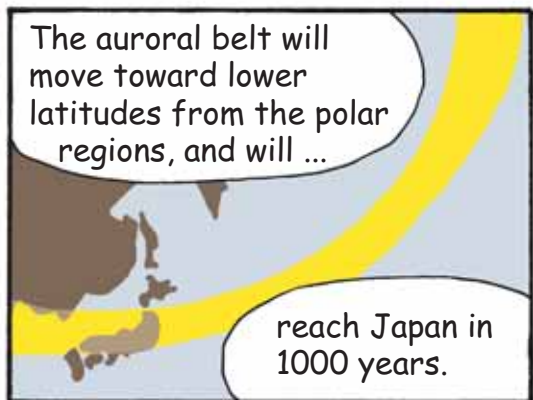
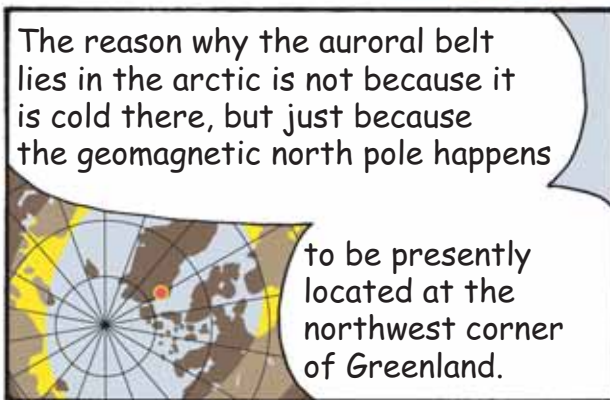
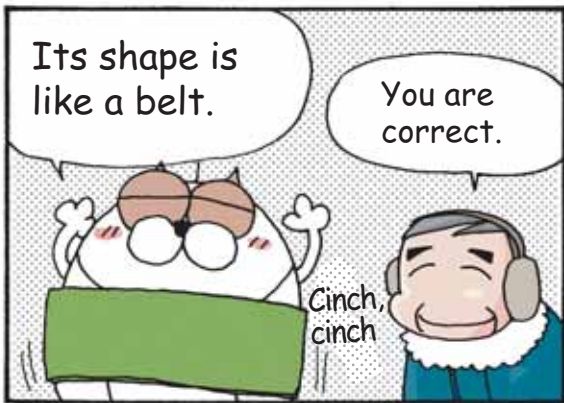
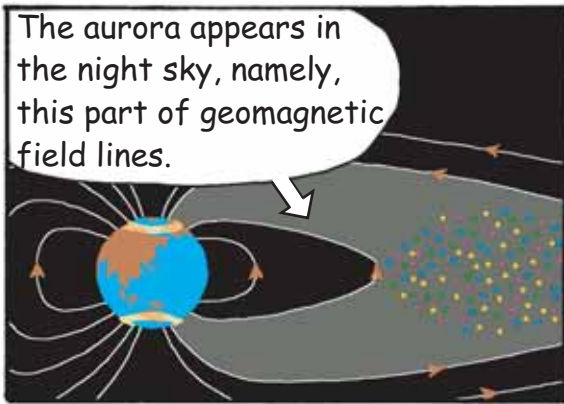
Where is today's scientific adventure for Mol and her robotic dog Mirubo?



They are flying over Yellowknife, Canada, at 62° north latitude.













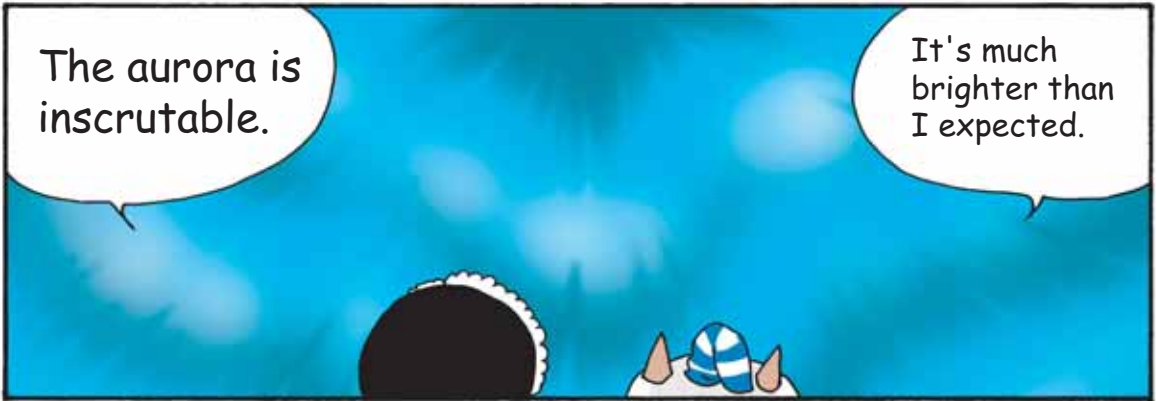
That was a wonderful aurora.

Hi, Aurora sensei.



This is called the "auroral breakup." An active one like this is rare.

You guys are very lucky!



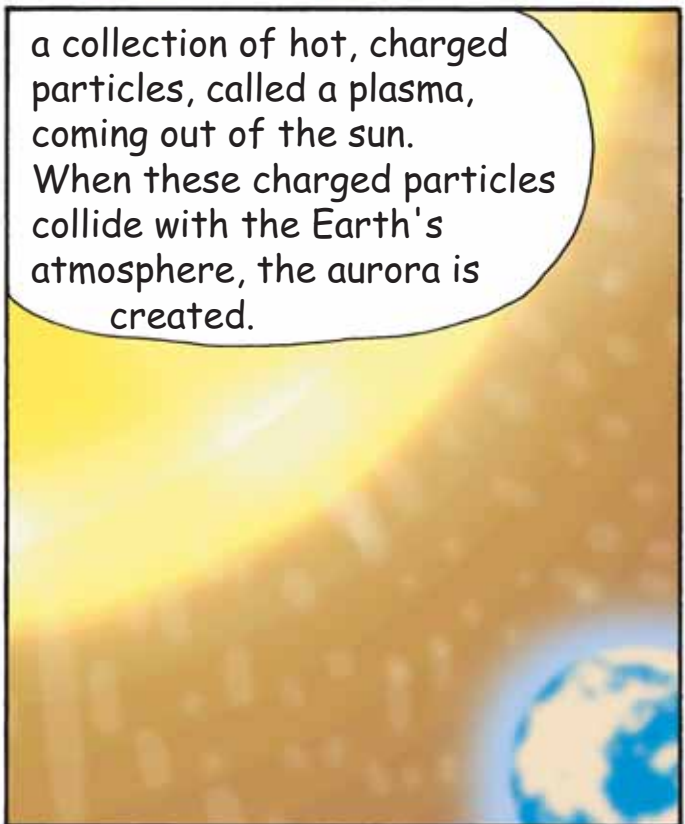
The aurora is inscrutable.

It's much brighter than I expected.

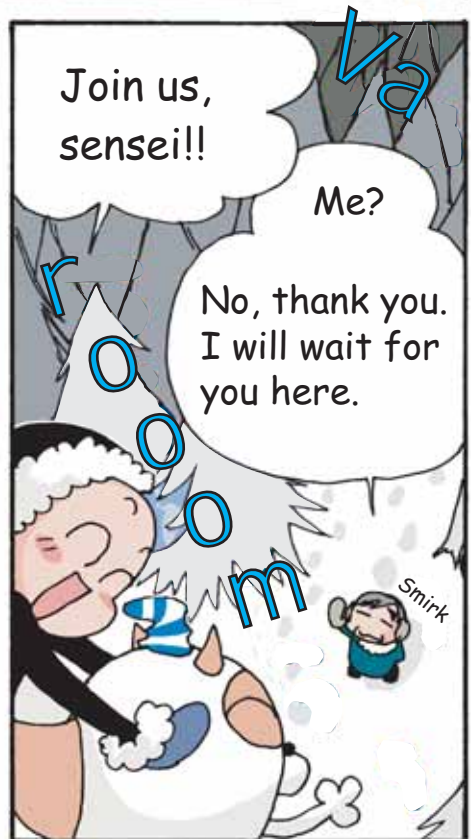
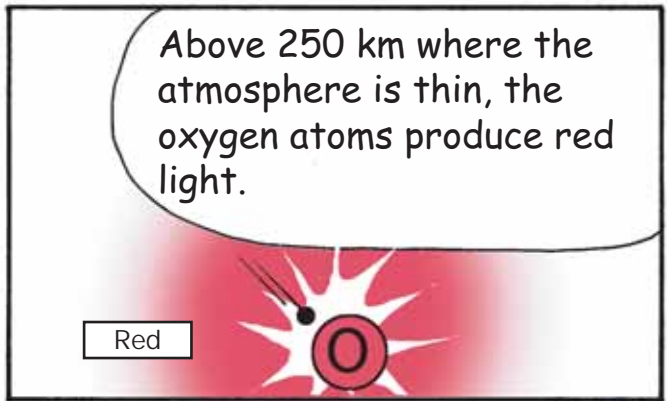
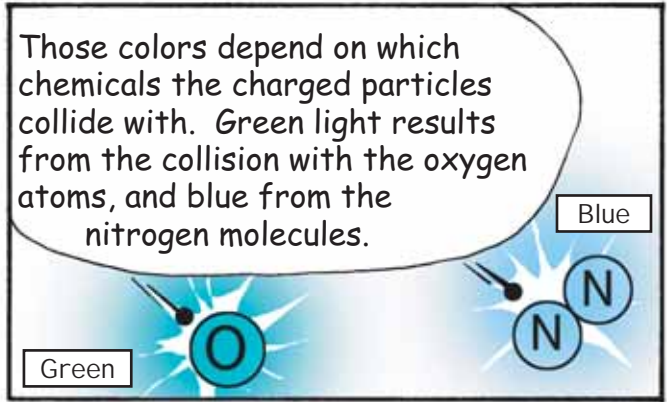


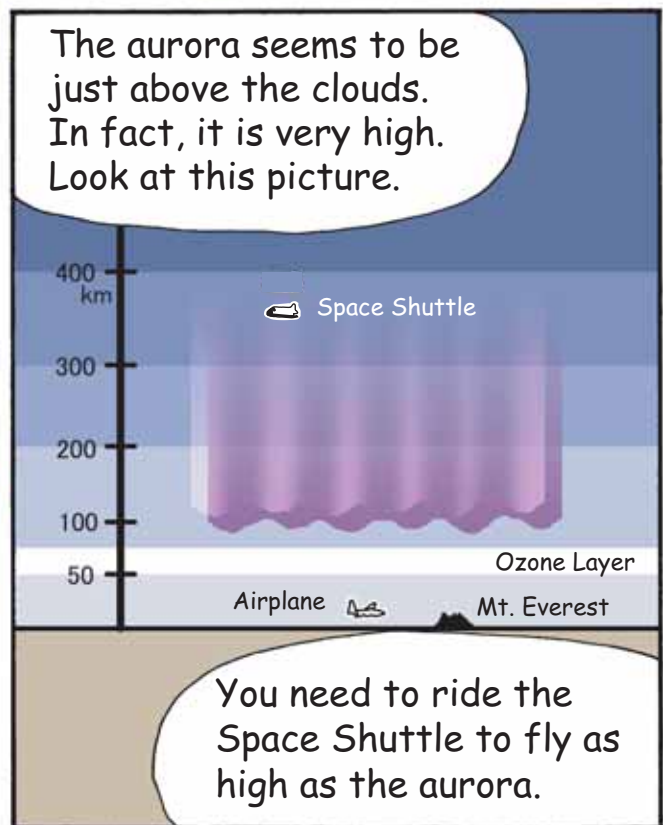
I wonder how the auroral lights are generated.

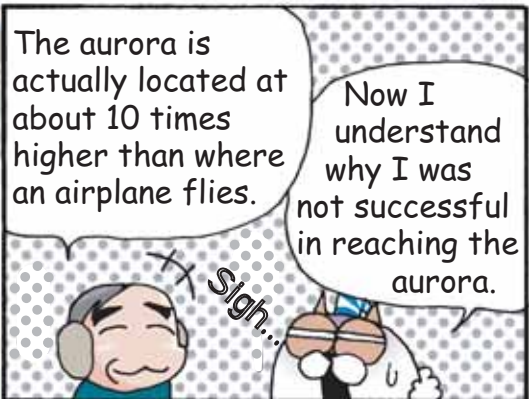
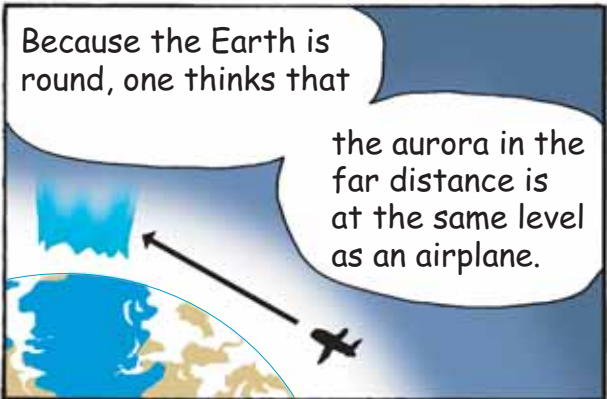
In the first place, the aurora is caused by ...

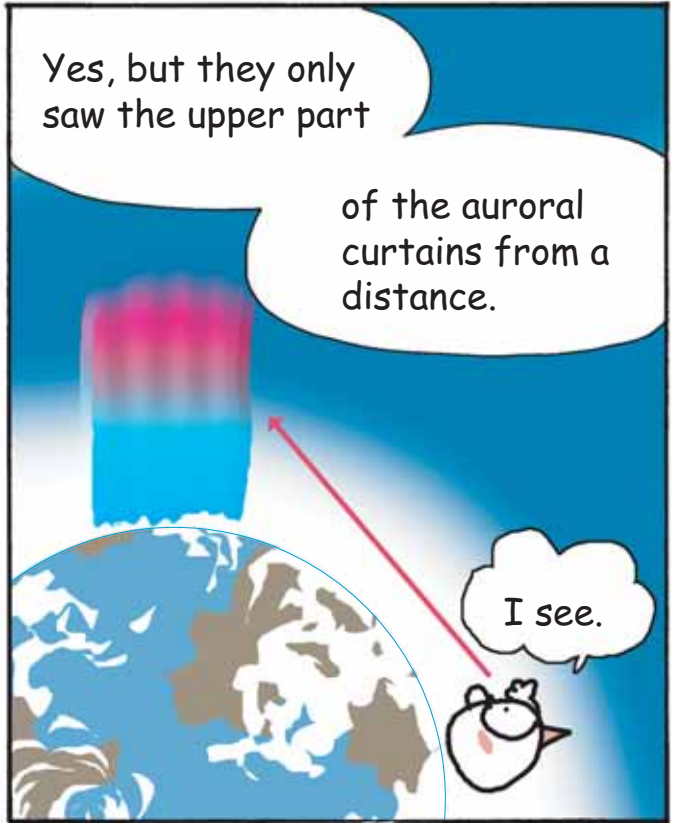


a collection of hot, charged particles, called a plasma, coming out of the sun. When these charged particles collide with the Earth's atmosphere, the aurora is created.











What is the Aurora?!



Nice to meet you again, Sensei! I saw a live TV program about auroras. That was amazing.



Yes. The aurora is a magnificent phenomenon, presenting a lot of unsolved mysteries. Hope you won't be too hard on me.



First, why does the aurora move just like a curtain does, stretching out in the vast sky?



Nobody would notice even if I could cut a little piece out of the aurora curtain.



You could nicely decorate your room with it, Mirubo. The auroral curtain is characterized by its folds, showing the direction of geomagnetic field lines. Charged particles coming down from space are accelerated along the magnetic field lines, then collide with the upper atmosphere. This collision creates the aurora.



Hum. The folds of the auroral curtain become inclined more at lower latitudes. The lower the latitude, the more the auroral curtain's folds become inclined.



Correct. The magnetic field lines are horizontal at the equator. Thus, auroras seen there must look like a UFO.



Do auroras occur in the equatorial regions??



In India experiments to create an artificial aurora were conducted. People there were so surprised to see the light, and local police offices received constant phone calls, claiming that a UFO had arrived.



Sensei, if I count the folds of auroral curtain one by one, will I find the number of the magnetic field lines?



No, because the magnetic field lines are invisible and not countable.



Why? We can see the folds up there.



Pardon me, I do not have an answer.



Well, then, why does the aurora move like it's dancing?



The aurora does not move, Mol.



Oh, I do not quite follow you.



Take an electric bulletin board or neon signs for example. Although light bulbs on the board never move, letters displayed there seem to shift one after another. To make certain letters formed and displayed, designated light bulbs should be lightened. The aurora "moves" in the similar way. Signals traveling from space down to the Earth decide which part of the sky glows.



It sounds like space is drawing a picture in our sky.



Exactly. The aurora works in a manner similar to that of your TV at home. In other words, the solar-terrestrial space displays the aurora on the huge screen above us, just the way producers make TV programs. Scientists are working on trying to understand the nature of space by observing the aurora.



Isn't it interesting that the aurora is a TV program produced by space for the natural screen of the sky, and we see it on TV?!



I understand that the aurora's birthplace is the sun. Why then does it occur only in the nightside of the Earth? Does it also exist in the dayside, but just cannot be seen?



The aurora is active on the night side. No matter how bright the sky is, we can capture the dayside aurora with radars. Charged particles coming from the sun travel into the nightside of the Earth.



How do they travel? And, why does the aurora often suddenly brighten up or start moving?



Sorry, but those questions cannot be answered to my knowledge.



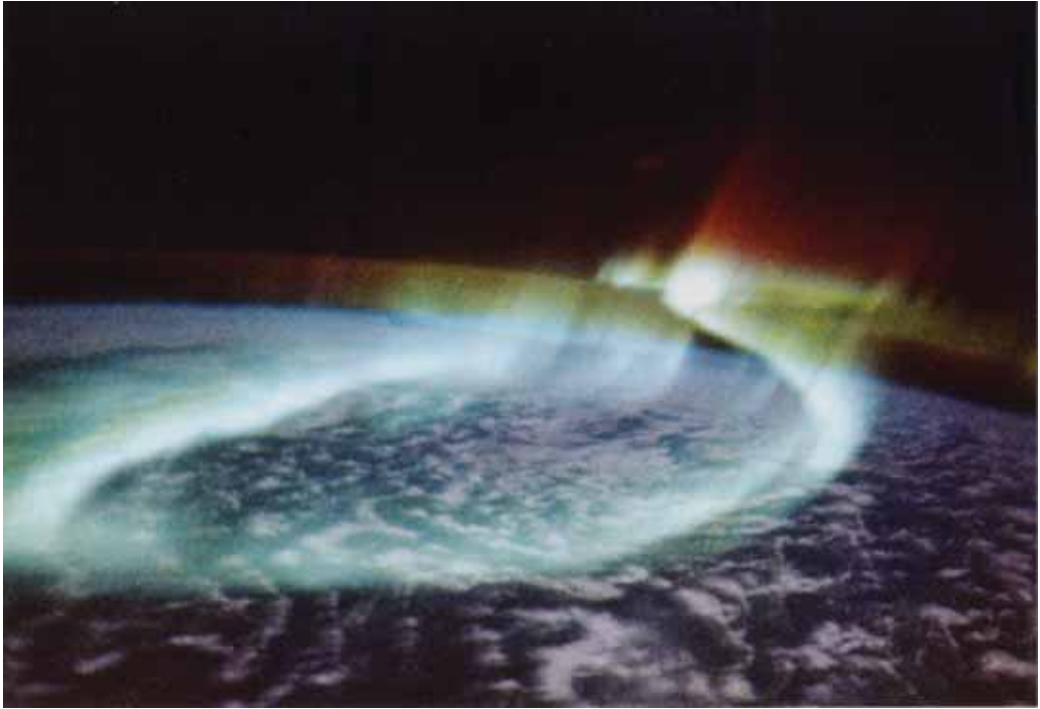
Don't mind, sensei. Are you able to forecast the aurora?



Yes, we can for some types of auroras. A large-scale aurora can be forecasted from satellite observations and geomagnetic field observations. Take a look! An aurora will appear in northern Canada in about an hour.



Whoopee! Let's go Mirubo!



A photograph from the Space Shuttle Discovery above auroral displays. <Courtesy of NASA>



Aurora reflected on a lake, just before dawn. <Photo by Yuichi Takasaka>



Needle-leaved trees and aurora shooting up the sky. <Photo by Norihisa Sakamoto>



Auroras were seen in Japan several times in late October to early November, 2003. These photos were taken in Rikubetsu, Hokkaido, showing red illuminations near the northern horizon. <Photos by Rikubetsu Astronomical Observatory>



Solar-Terrestrial Environment Laboratory (STEL), Nagoya University

STEL is operated under an inter-university cooperative system in Japan. Its purpose is to promote "research on the structure and dynamics of the solar-terrestrial system," in collaboration with a number of universities and institutions both in Japan and abroad. The Laboratory consists of four research Divisions: Atmospheric Environment, Ionospheric and Magnetospheric Environment, Heliospheric Environment, and Integrated Studies. The Center for Joint Observations and Data Processing is also affiliated to the Laboratory to coordinate joint research projects and construct data bases. At its seven Observatories/Stations, ground-based observations of various physical and chemical entities are conducted nationwide.

<http://www.stelab.nagoya-u.ac.jp/>



National Geophysical Data Center (NGDC) Space Environment Center (SEC)

National Oceanic and Atmospheric Administration (NOAA)

NGDC and SEC of NOAA, located in Boulder, Colorado, are part of the US Department of Commerce. NGDC provides scientific stewardship, products and services for geophysical data describing the solid earth, marine, and solar-terrestrial environment, as well as earth observations from space. Continually monitoring Earth's space environment, SEC provides reliable and useful solar-terrestrial information, conducts research and development programs to understand the environment, and plays a leadership role in the space weather community.

<http://www.ngdc.noaa.gov/>

<http://www.sec.noaa.gov/>

はやのん Hayanon

Graduated from the Department of Physics of Ryukyu University, Hayanon, a writer and cartoonist, has contributed a number of serials in popular magazines on the basis of her strong background in science and computer games. Her consistent writing style, expressing a love for science, is well accepted.

<http://www.hayanon.jp/>

子供の科学 Kodomo no Kagaku (Science for Children)

Kodomo no Kagaku, published by the Seibundo Shinkosha Publishing Co., Ltd. is a monthly magazine for juniors. Since the inaugural issue in 1924, the magazine has continuously promoted science education by providing various facets of science, from scientific phenomena in everyday life to cutting edge research topics. <http://www.seibundo-net.co.jp/>

"What is the Aurora?!" is published with cooperation of Kodomo no Kagaku, and with advice by K. Shiokawa. Mol, Mirubo, and Sensei thank E. Kihn, Terry Onsager, Bernie Shizgal, and Roland Tsunoda for their help in preparing the English version of our story.

Produced by the Solar-Terrestrial Environment Laboratory, Nagoya University under the auspices of the Ministry of Education, Culture, Sports, Science and Technology.

April 2004

All rights reserved.