WHY STUDY THE AURORA?

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OUTLINE

• THE SOLAR WIND AND THE MAGNETOSPHERE
• IMPACTS ON EARTH
• HOW TO TAKE PHOTOS OF THE AURORA?
• WHY SVALBARD?
• THE KJELL HENRIKSEN OBSERVATORY AT BREINOSA
There is wind in space: Solar wind!

Sun: 26 days rotation; $D = 100 \times D_E$

A solar wind journey / animation:

Animations @ UiO
A MORE DETAILED VIEW OF THE MAGNETOSPHERE

EARTHS FIRST DEFENCE

The Earth has a magnetic field:

What happens active sun conditions?

NB! MAGNETIC SHIELD IS **ON** FOR IMF POINTING NORTH & **OFF** FOR IMF SOUTH
AURORA

THE EARTH'S ATMOSPHERE IS THE LAST DEFENCE
The Auroral forms

HA – homogeneous arc
RA – arc with ray structure
HB – homogeneous band
RB – bands with ray structure
R – rays,
C – corona
D – drapes (curtains)
S - Spirals
Proton Aurora

Charge capture \[ H^+ + M \rightarrow H^{(n)} + M^+ \]

Charge stripping \[ H + M \rightarrow H^+ + M + e^- \]
IMPACTS ON EARTH

Radiation

Flares are classified according to peak intensity X-ray:

B, C, M & X.

Each with 9 subdivisions.

Atmospheric Response
Impacts: Magnetospheric Ion Outflow

The SCIFER 2 Payload

Rocket assembled on launcher, Andøya
Impact on the Mesosphere?

Shuttle image of aurora

KHO
7 Dec 2010
22:30 UT

AIRGLOW
OH(6-2)

RGB [8400, 8446 & 8465] Å
Large proton events deplete the upper level ozone for weeks to month (Jackman et al. GRL 28, 2883, 2001). These short term effects can destroy up to 70% of the ozone in the middle stratosphere.
FUTURE: PLASMA FUSION REACTORS?

Leakage of diffusion across the magnetic field is the main problem to be successful with controlled fusion of Hydrogen atoms.

We study the same things in nature!
Planetary Auroras

UV Images from the Hubble Telescope

Saturn

Jupiter

Auroras reveal existence of Planetary magnetic fields and atmospheric composition!
LOCATION: AURORA OVAL TERMS

12 MLT

DAYSIDE

06

POLEWARD BORDER $\theta_p$

EQUATORWARD BORDER $\theta_e$

NIGHTSIDE

Note: Size and location depends on magnetic activity or Kp index
GEOMAGNETIC ACTIVITY

The **K-index** quantifies max disturbances in the horizontal component of earth's magnetic field during a 3 hour period.

Planetary estimated **Kp index** is derived by calculating a weighted average of K-indices from a network of geomagnetic observatories (US Air Force) and NOAA.

Using data from solar satellites, located 1 hour upstream in the solar wind, we get the **predicted Kp index**.

Prediction time ~ 60 minutes
THE AURORA OVAL FORECAST 3D APP!

New cross platform application
iOS, OSX, Android and Windows

Forecasts: 0, +1, +6 hours up to 3 days

3D scaling and rotation of Globe

Not only predefined Stations. It forecasts anywhere on the planet.

Current status: β – testing.
Also includes star and planet sky view + Satellites.

Software: fredware
### DSLR
Digital Single Lens Reflex  
Circular Fisheye 180°  
Time resolution: 5 - 30 s  
Camera: Nikon D7000  
Lens: Sigma 4.5mm f/2.8  
Nikon D7000 -16M pixels  
Color matrix: RGB

### INTENSIFIED CCD
4th Gen Light intensified vacuum tube  
Circular Fisheye 180°  
Time resolution: 25 msec (real time)  
Camera: Video CCD  
NTSC: 30 frames/second  
Monochrome  
Frame accumulation ~1s (30 frames)

### Color EMCCD camera
Electron Multiplying Charge Coupled Device  
Circular Fisheye 185°  
Time resolution: 25 msec (real time)  
Camera: Raptor Hawk EM246  
PAL: 25 frames/second  
Color matrix: CYMG  
Frame accumulation ~1s (25 frames)

Price (US $) :  
- ~ 1K  
- ~ 2K  
- ~ 60K  
- 60 - 90K  
- ~9K
THE DSLR CAMERA

The Digital Single Lens Reflex camera

Aurora
1) Look at the auroral forecast to find pointing direction.
2) Use a tripod and self trigger.
3) Open to maximum aperture (low F-number)
4) Set focus to infinity
5) Use detector (CCD) settings on?
THE CCD
The Charged Coupled Device

CCD with Bayer color filter mosaic (Wikipedia)

Metals or non-metallic solids like phosphorus doped silicon.

CCD Principle
Janesick et al. (1987)

The photoelectric effect
“The Unity Gain ISO is the ISO of the camera where the A/D converter digitizes 1 electron to 1 data number (DN). Since 1 electron (1 converted photon) is the smallest quantum that makes sense to digitize, there is little point in increasing ISO above the Unity Gain ISO” (http://www.clarkvision.com).
NOTE
Upper red emissions from [OI] 6300 Å has a lifetime of 110 s, while lower green [OI] 5577 Å only is 1s.

Fast moving emissions along lower border of the auroral arcs are produced by high energetic electrons exciting molecules $N_2$, $N_2^+$... life times $<1s$. 

Fujifilm S2Pro, 30 s exposure ISO 1600, f/2.8
SPECTRA OF THE AURORA

WAVELENGTH [Å]

INTENSITY [R/Å]

SPECTRAL RESPONSIVITY [MCTS/R]

[Image of a graph showing the spectra of the aurora with various wavelengths and intensities]
Svalbard is like a slow satellite with an orbit moving in and out of the auroral oval!

+ It is dark in the daytime during winter (dayside aurora)
The University of Oslo – Physics Dept./ Norwegian Institute for Cosmic Physics Observatory (Omholt / Egeland) on Breinosa, October, 1970.

The Auroral Station in Endalen (1978)

The current shape of the Auroral Station in Adventdalen (2005)

The dedicated scientists - pioneers

The Auroral Station in Adventdalen (1984)

Expansion in 1988

Platform Expansion 2002

The Auroral Station in Endalen stamp (1978 - 1983)
KHO 2008

1) Instrumental module (30x)
2) Service Section
3) Platform

Location

Prof. Dr ² K. Henriksen
Instruments @ KHO

In addition:

a) Magnetometers
b) Scintillation receivers (GPS)
c) Riometer
d) Weather station
e) Web cameras
Institutions @ KHO

1. University Centre in Svalbard
2. University of Oslo
3. University of Tromsø
4. University of Bergen
5. University of Alaska, Fairbanks
6. University College London
7. University of Wales Aberystwyth
8. University of Southampton
9. University of New Hampshire
10. University of Rome
11. University of Calgary
12. Augsburg College
13. Tohoku University
15. Finnish Meteorological Institute (FMI)
16. Danish Meteorological Institute * (DMI)
17. Institute of Radio Astronomy (Ukraine)
18. The Polar Institute of China (PRIC)
19. NORSAR
20. National Institute for Aeronautics (LAPAN)
21. Technische Universität Berlin (TU)
22. Korea Polar Institute (KOPRI)
23. Kongsberg Satellite Service (KSAT)
24. University of Madrid (UCM)

… & excellent students!
PARTNERS @ Lyr

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