



UiO : **Department of Physics**
University of Oslo

FYS3610 – Introduction

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Outline

- Technicalities
- Kristian Birkeland
- Sun-Earth connection, northern lights
- Space weather impact
- 4DSpace research initiative
- Student opportunities



Technicalities

- Website
- List of participants
- Project work
 - Pick a date from the list
 - Groups of two
 - 10-15 pages
 - Due by **27 November 2016**
- Exams



Overview over lectures

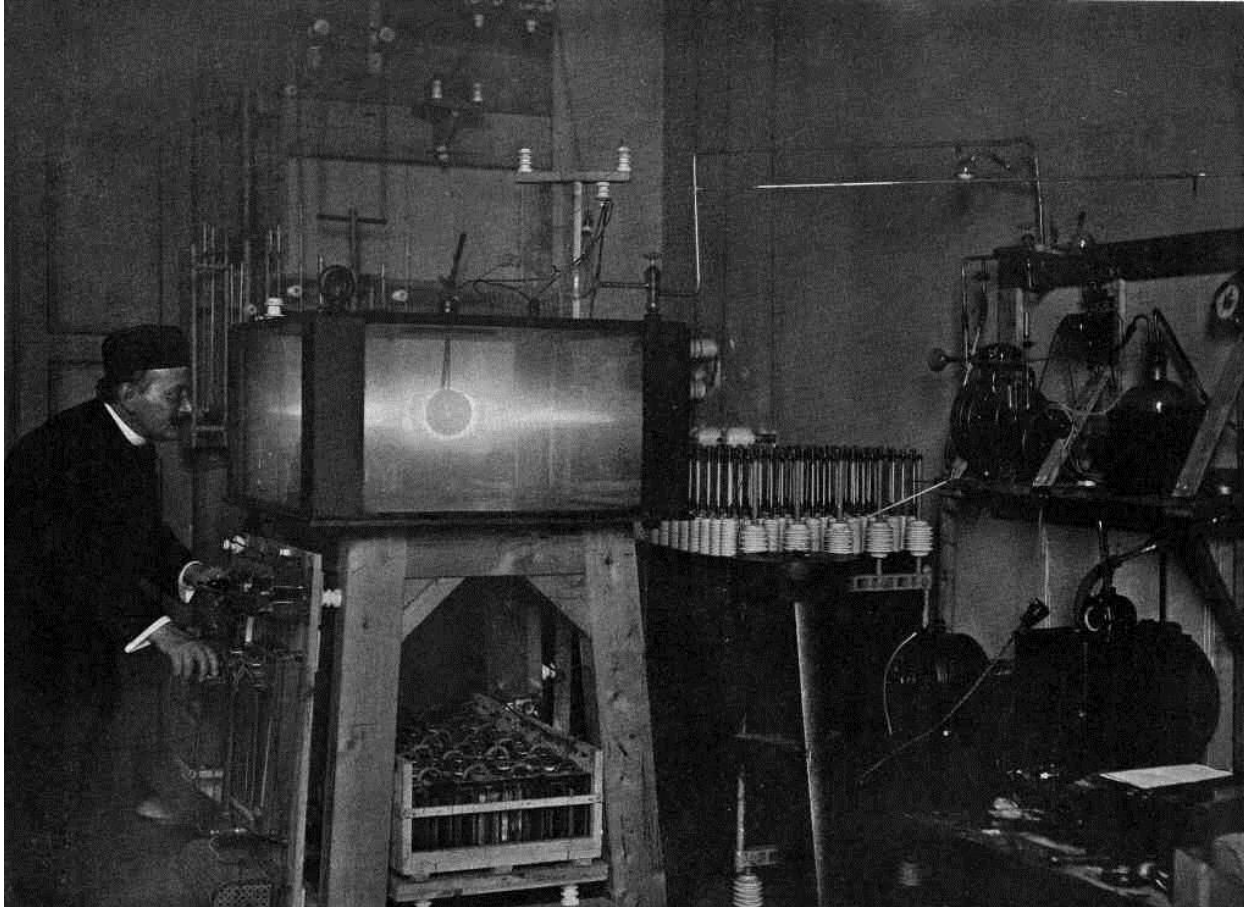
Week	Topic	Keywords	Curriculum
34	Introduction, plasma basics	Gyration, 1st order drifts, magnetic mirror, loss cone	BSP Ch. 2 PESE Ch. 5.3
35	Magnetohydrodynamics	Particle distribution function, Vlasov equation, MHD equations, magnetic reconnection, Debye length, plasma frequency	BSSP Chs. 1.1, 6.1, 6.2, 6.5, 7.3
36	The Sun	Internal structure, atmospheric layers, dynamics	PESE Ch 3.1 lecture
37	Solar wind	Properties, Parker model, Parker spiral, sectoring & current sheets, radial dependence	PESE Chs. 6.1 & 6.2
38	Structure of the terrestrial magnetosphere	Internal magnetic field, spherical harmonic expansion, dipole description, Chapman-Ferraro current, tail current	PESE Chs. 5.2, 6.4, 6.5
39	Structure of the ionosphere	Ionization profile, D-, E-, F-layer, dynamics	PESE Chs. 3.2, 4.1-4.4
40	Structure of the atmosphere	Composition, thermal structure, Ozone & UV radiation	PESE Chs. 2.2 & 2.3
41	Midterm exam		
42	Open magnetosphere	Dungey cycle, corotation, convection, ECPC	BSSP 5.2-5.4
43	Ionospheric conductivity and currents	Pedersen/Hall conductivities, collision frequencies/mobilities, region 1/2 currents	BSSP 4.2, 4.4 PESE 7.2 7.3
44	Substorms and aurora	Generation of aurora, proton aurora, substorm phenomenology	BSSP 5.6 PESE 7.4, 8.1
45	Plasma interactions with other planets	Interaction with unmagnetized bodies, radiation belts	Lecture
46	Instrumentation	Incoherent & coherent scatter radars, magnetometers, all-sky imagers	Lecture
47	Reports, repetition		
48	Exam		

Kristian Birkeland (1867-1917)

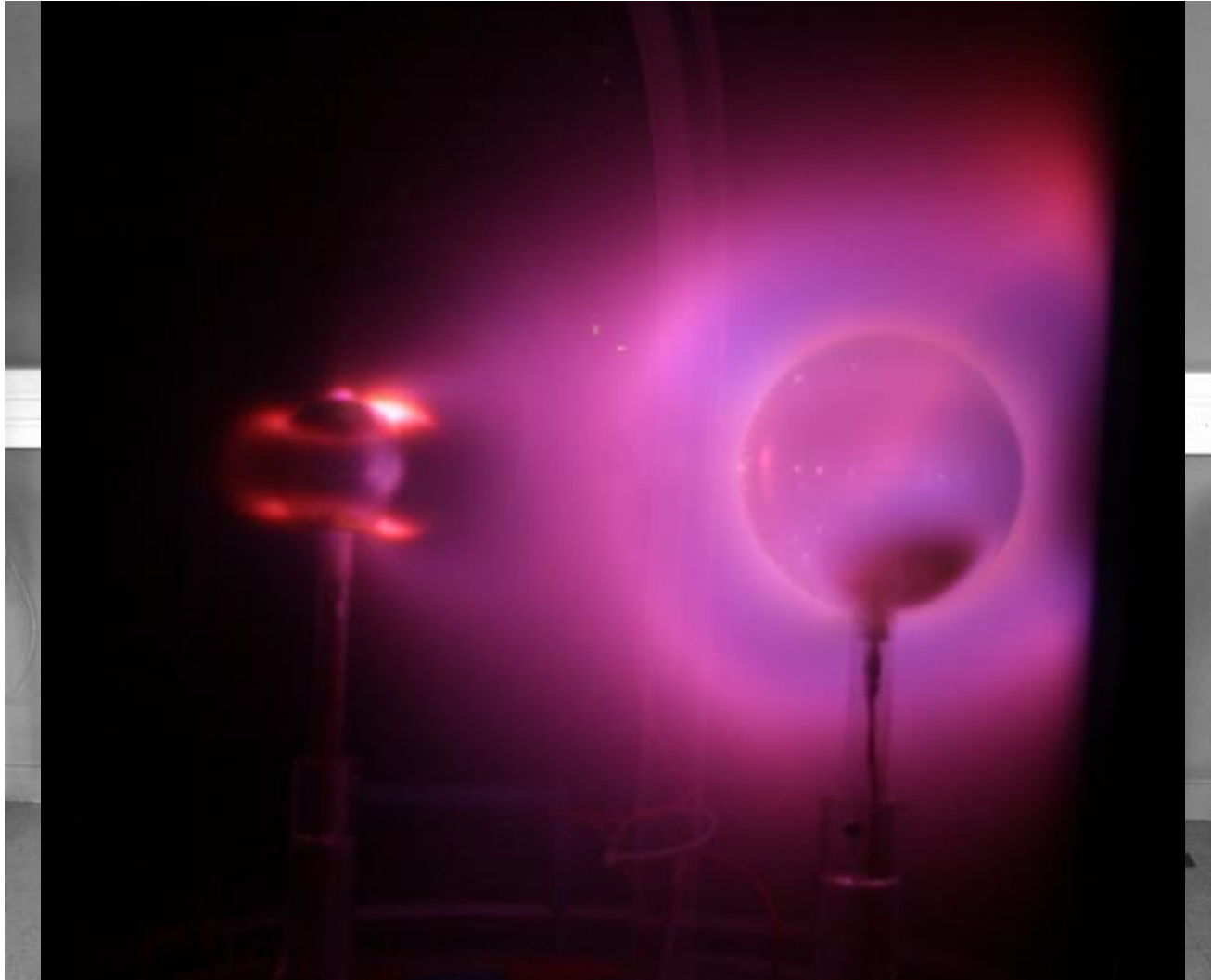
- The "first auroral physicist"
- Professor at 31 years old
- Experiment + Theory = Innovation (60 patents)
- Fixation of Nitrogen – gave birth to Norsk Hydro/Yara - a world leading fertilizer company
- After three expeditions in 1902-1903 he concluded that northern lights are associated with currents floating along magnetic field lines – The Birkeland currents



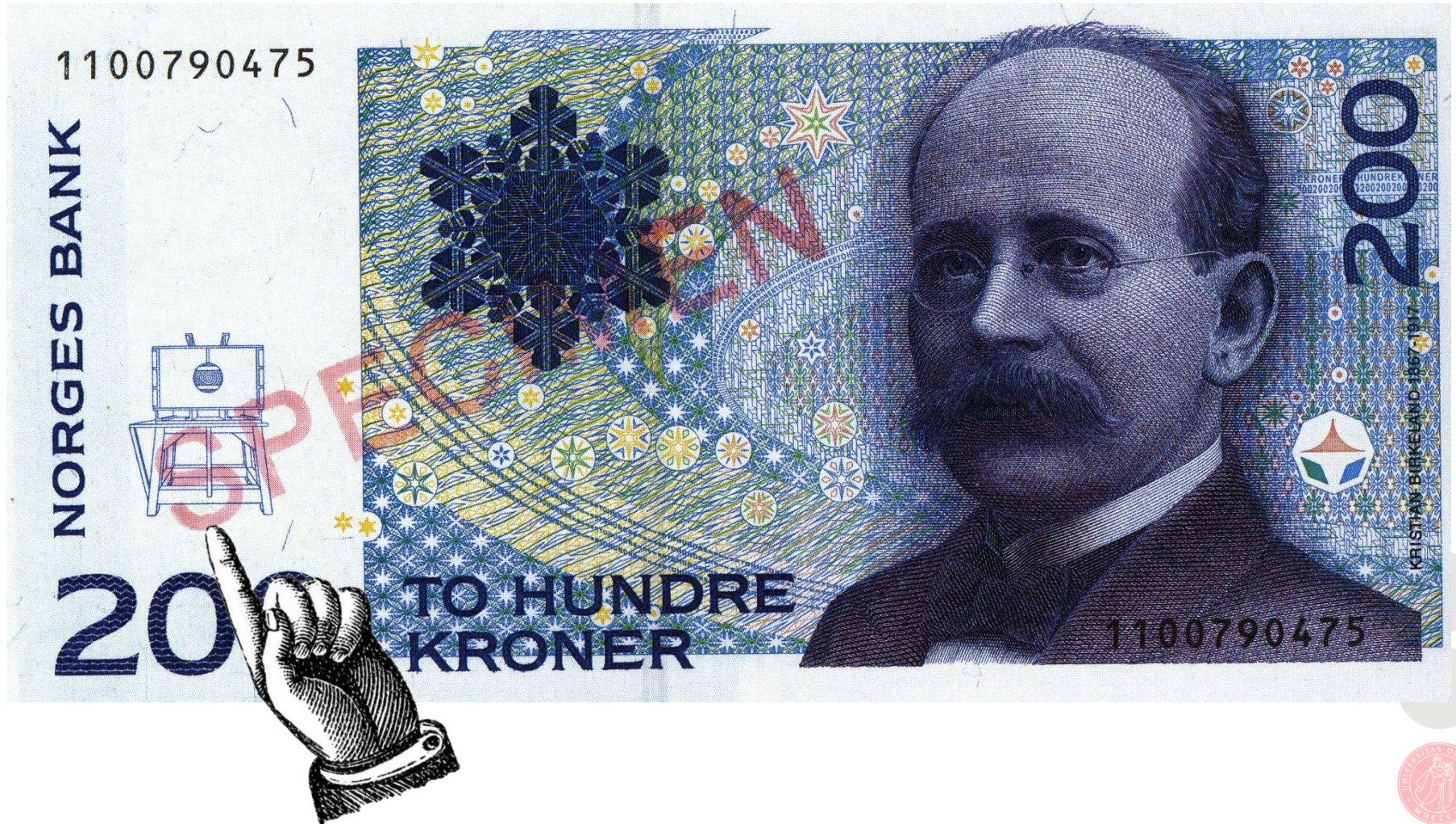
The Terrella (1901)



The Terrella (2015)



The Terrella



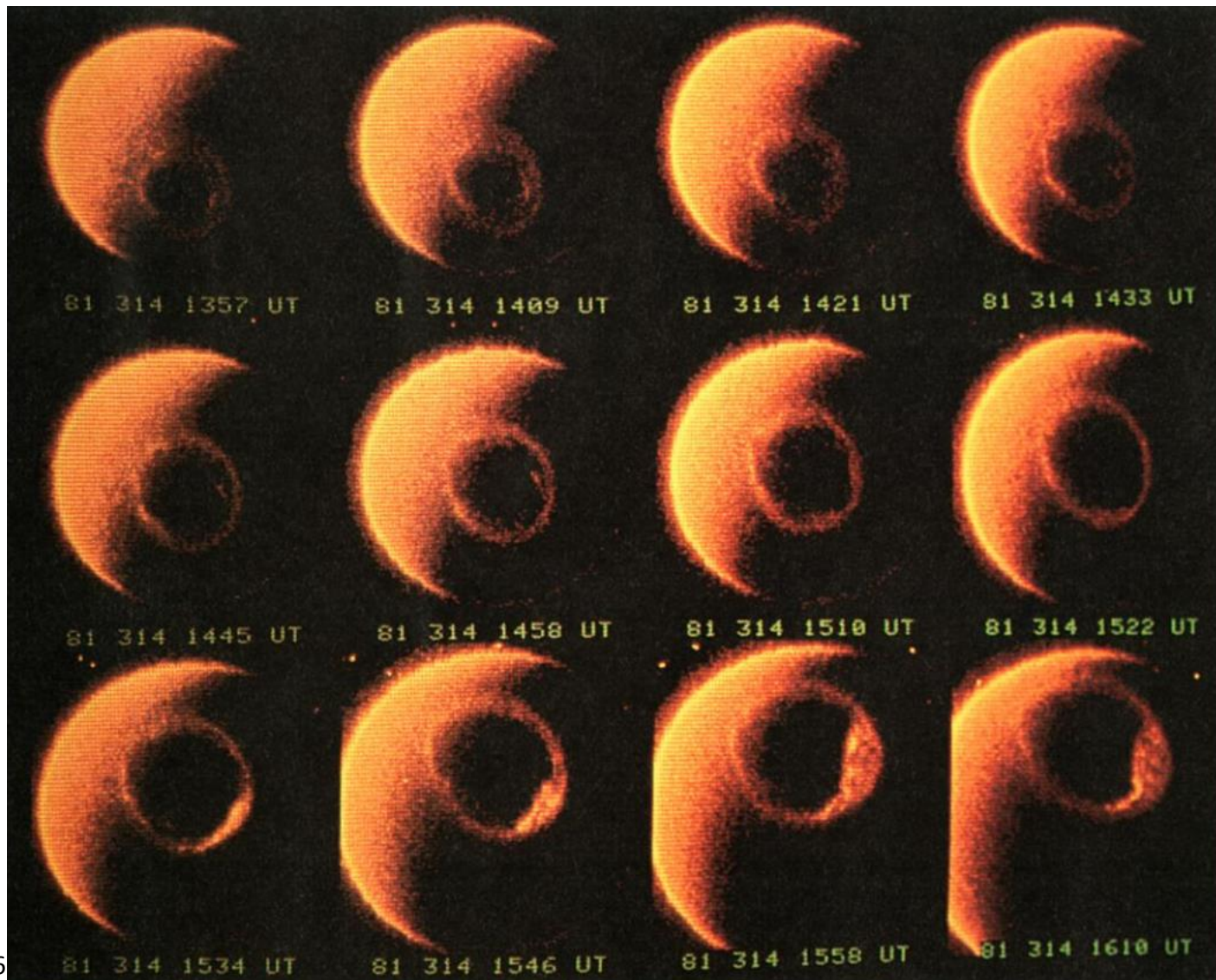
Birkeland currents



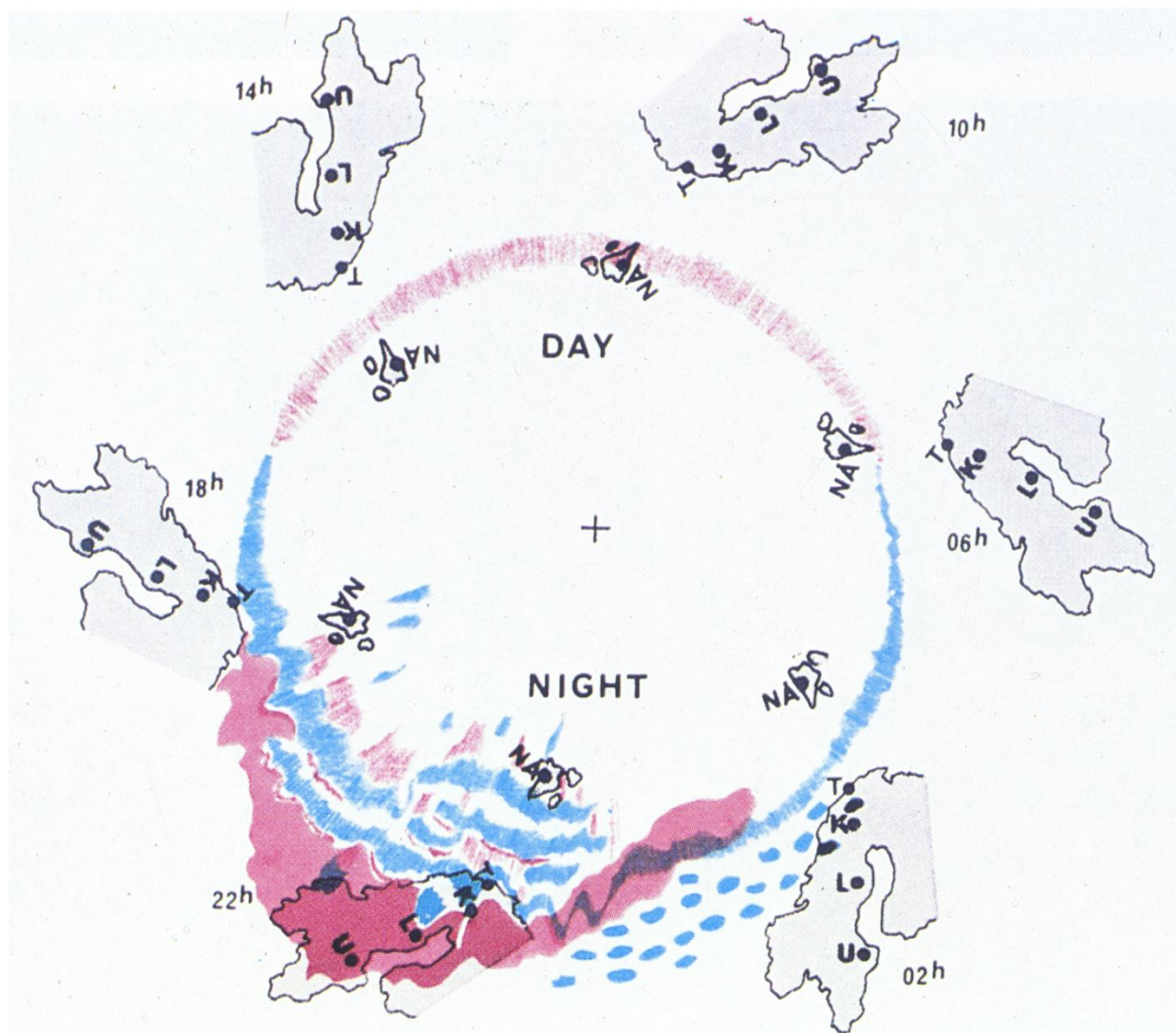
Birkeland currents



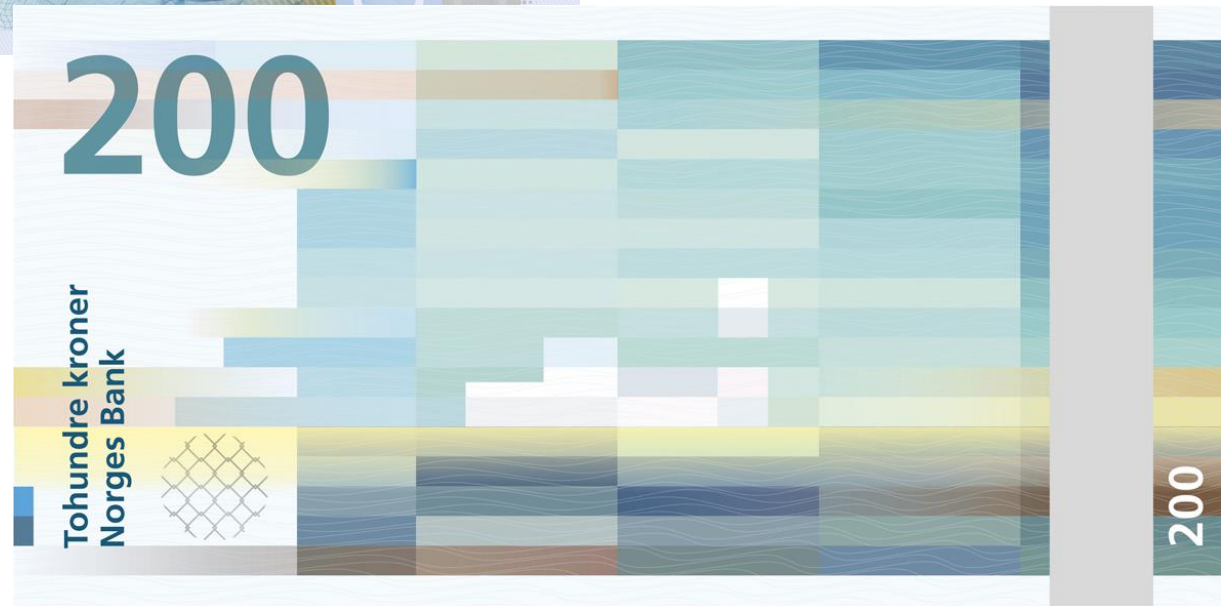
The auroral oval



Norway's fortunate location

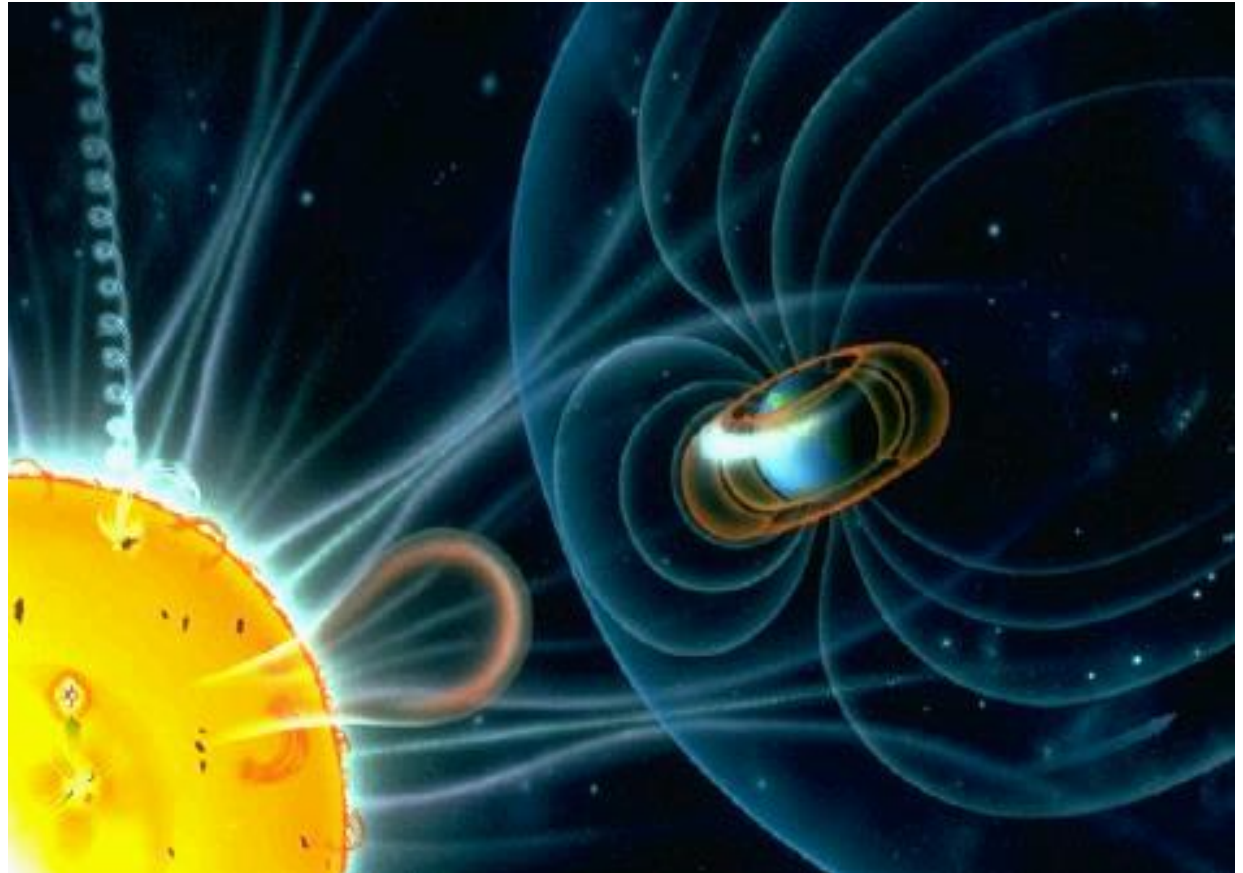


Buuuh!



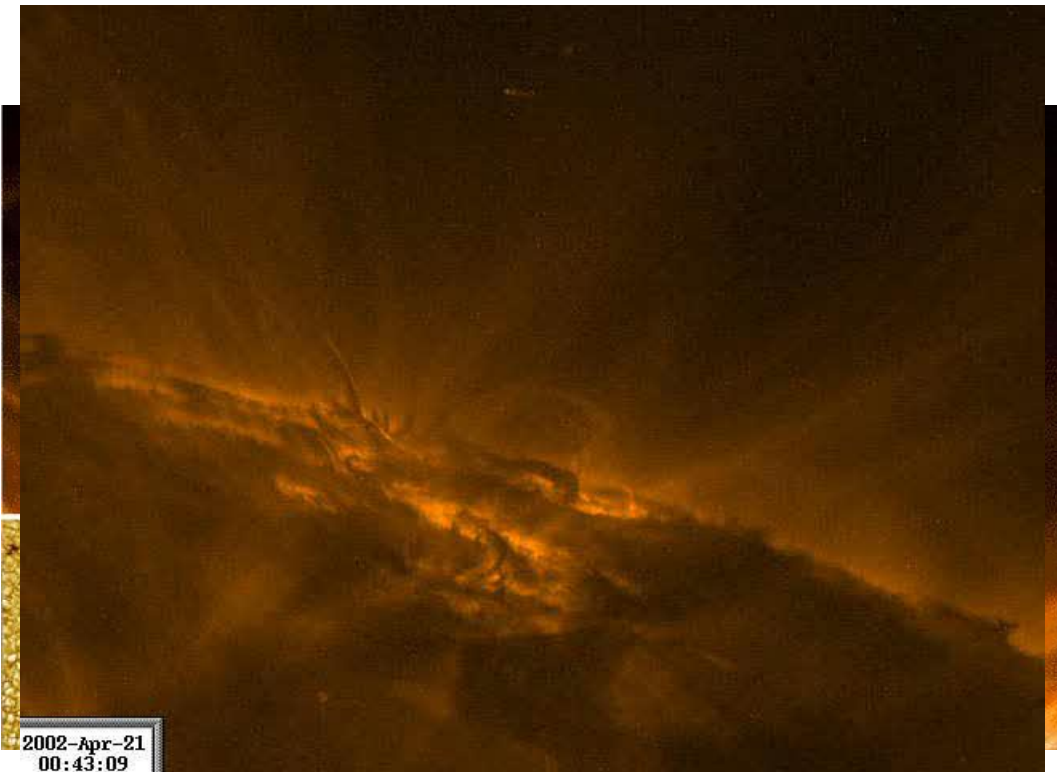
Living with a star

We live in the extended atmosphere of a variable star – the Sun



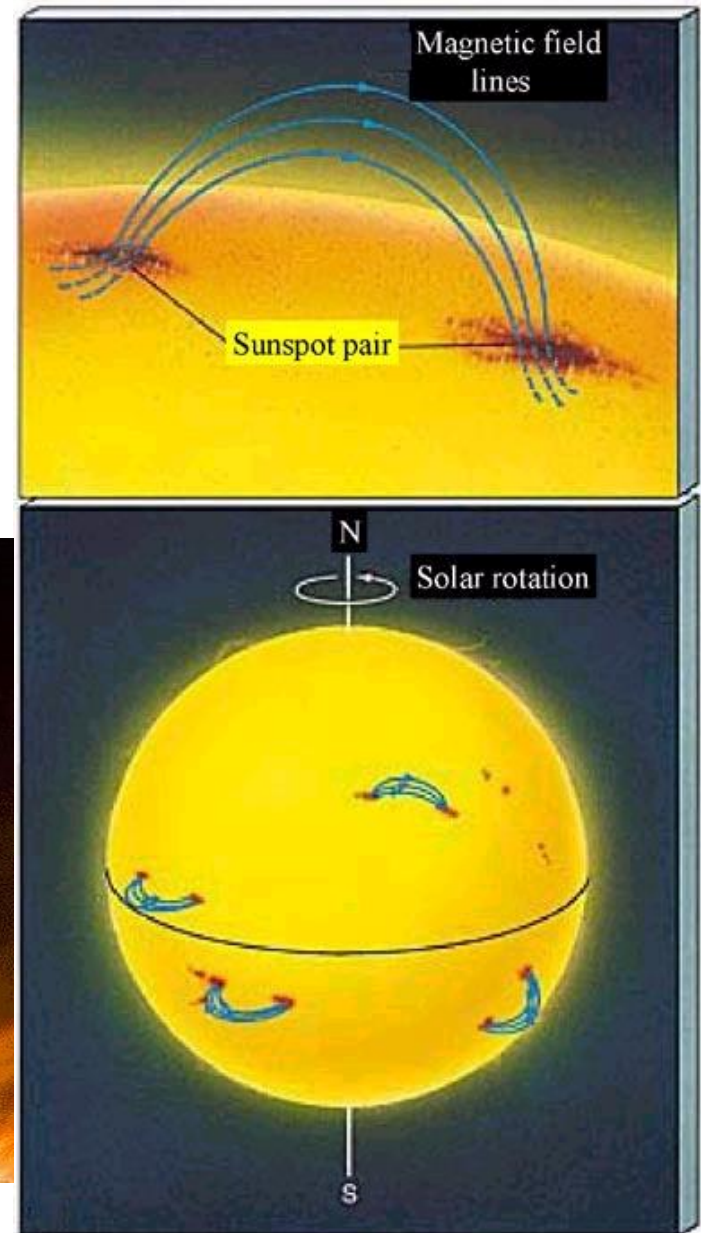
Dynamic Sun

- The Sun also has a magnetic field
- Sun spots occur in pairs connected by magnetic field lines

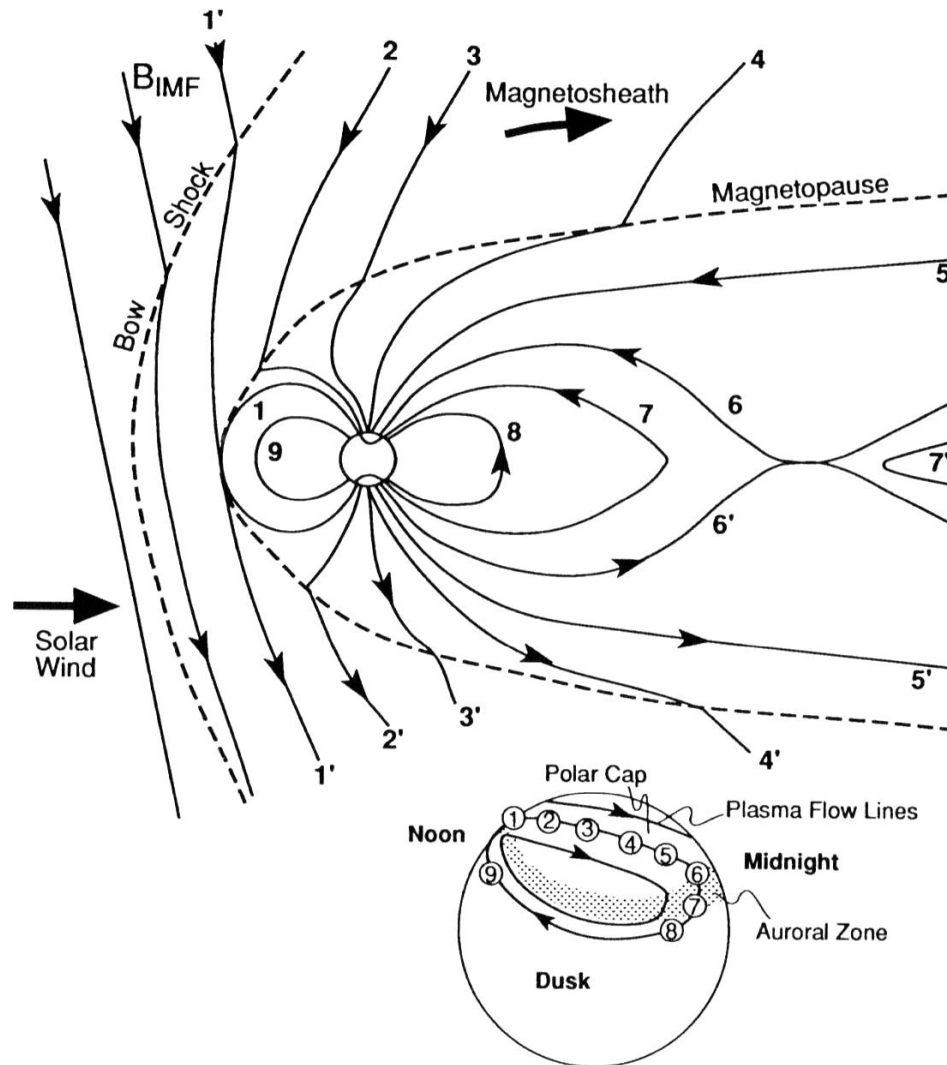


2002-Apr-21
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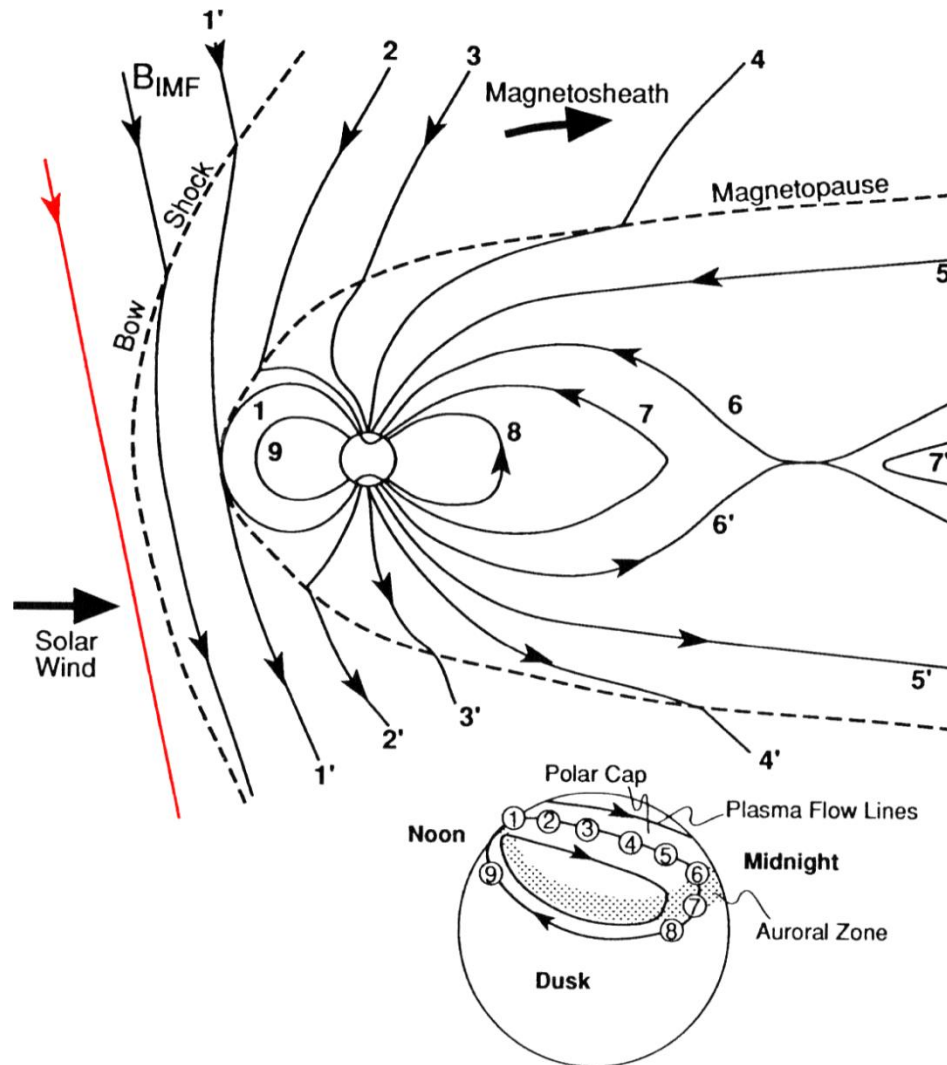
8/23/2016



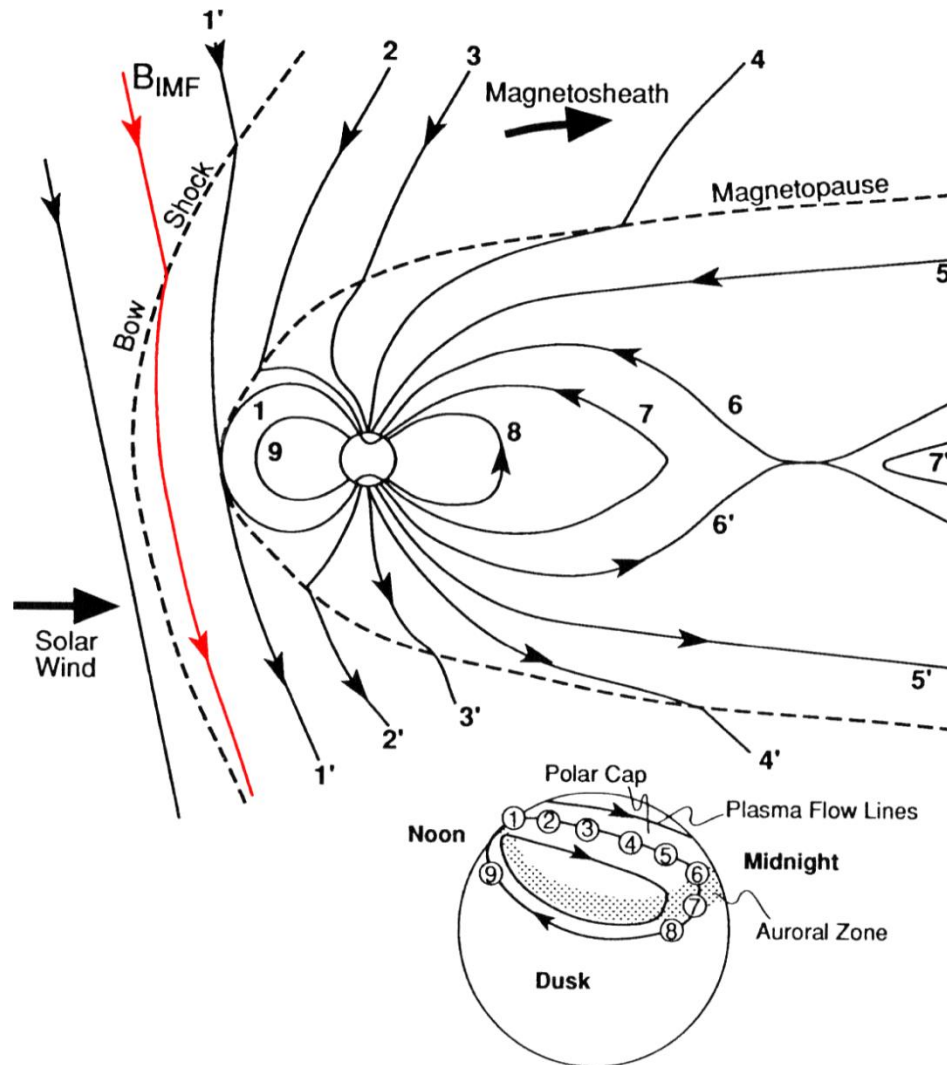
Sun-Earth interaction



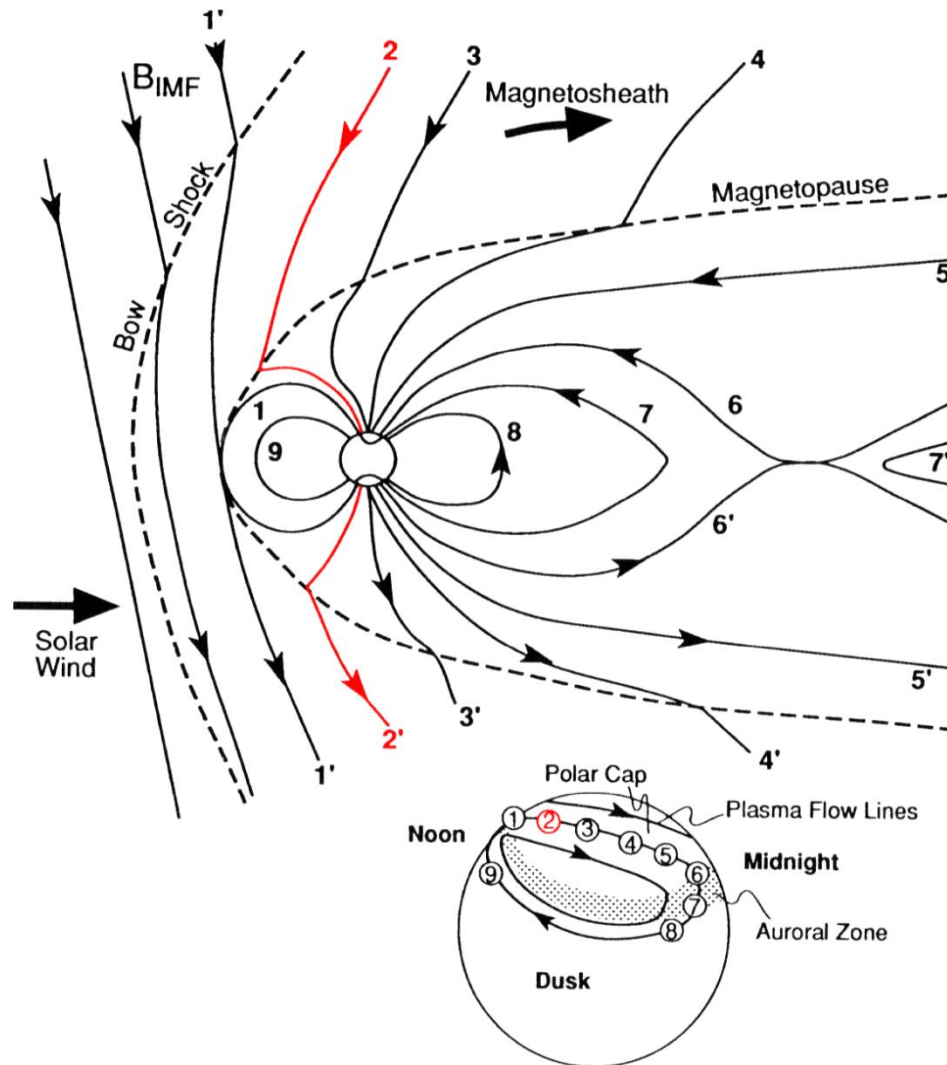
Sun-Earth interaction



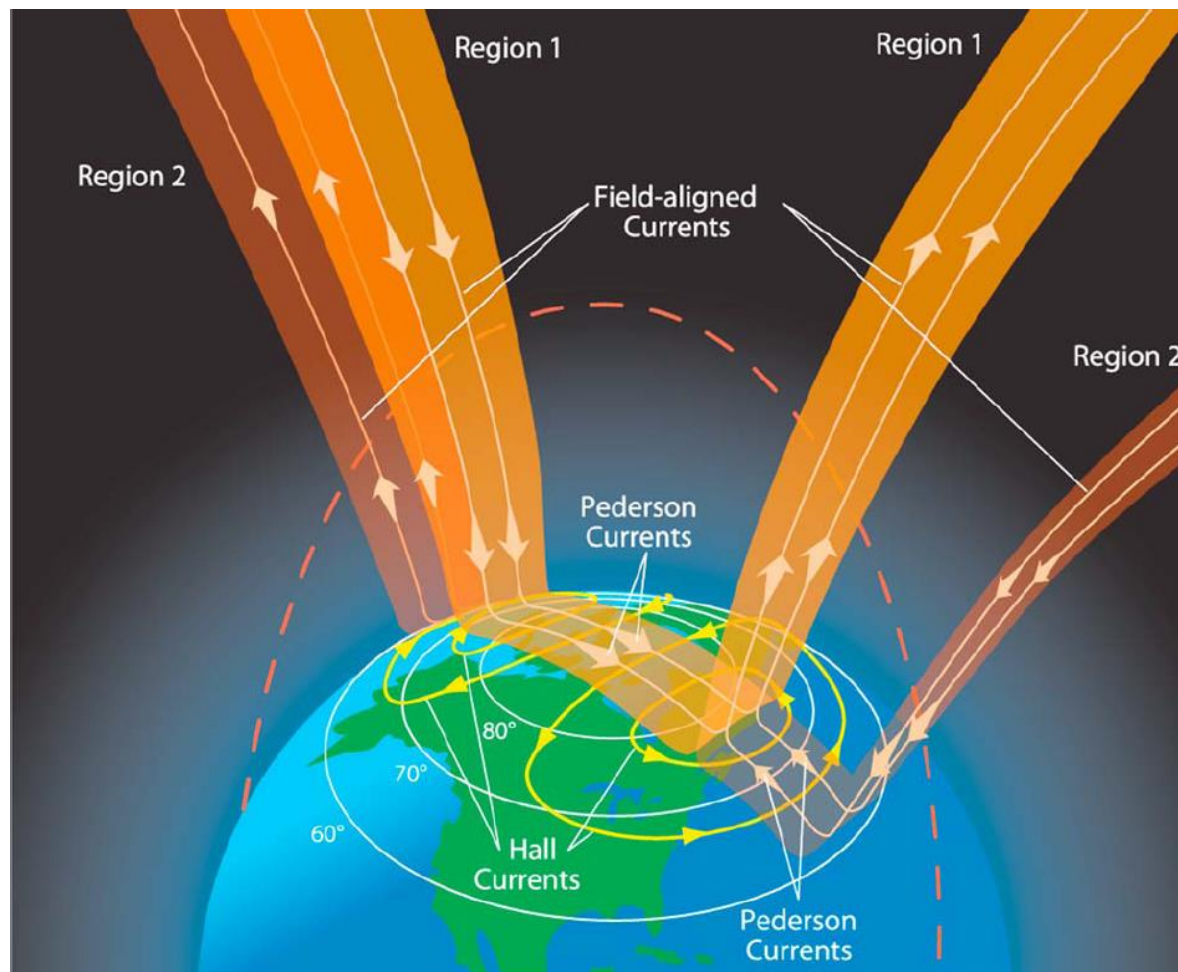
Sun-Earth interaction



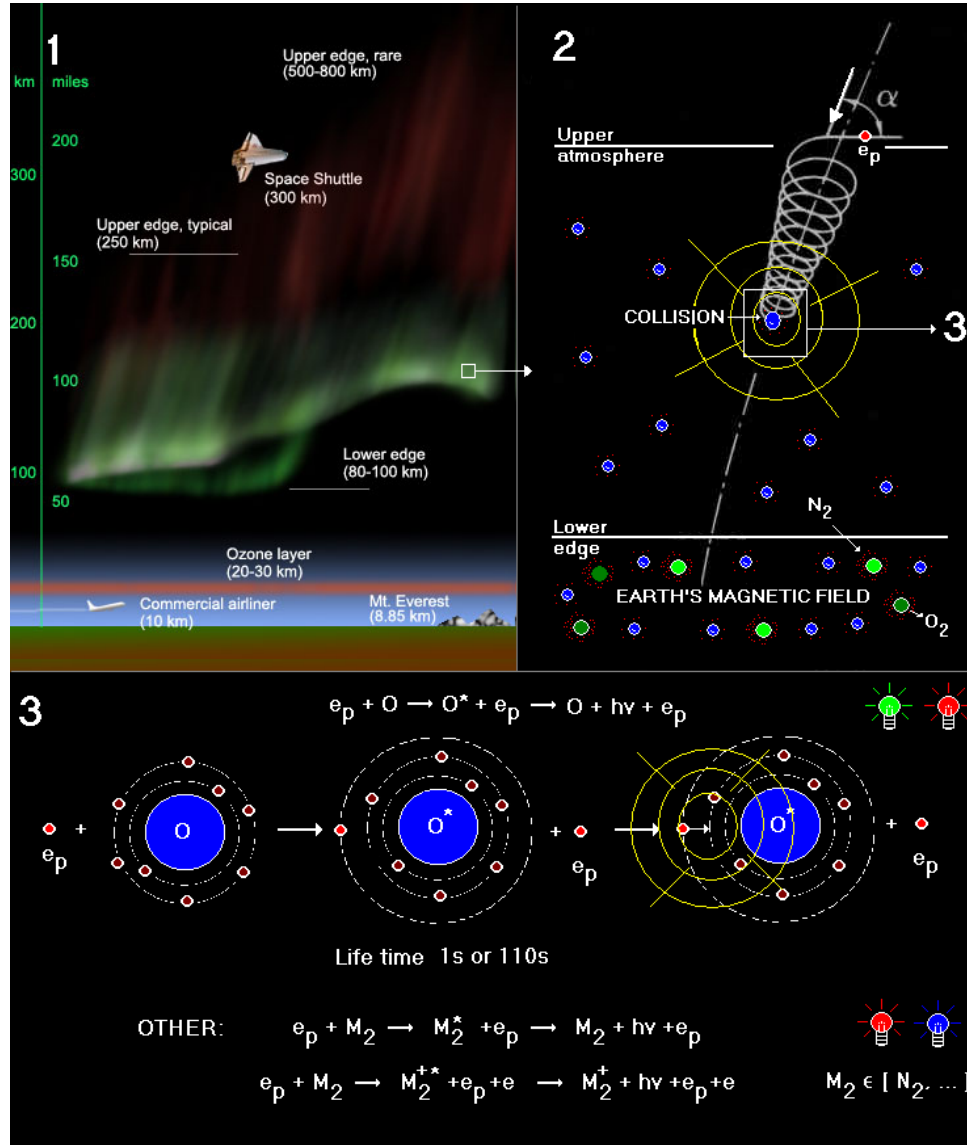
Sun-Earth interaction



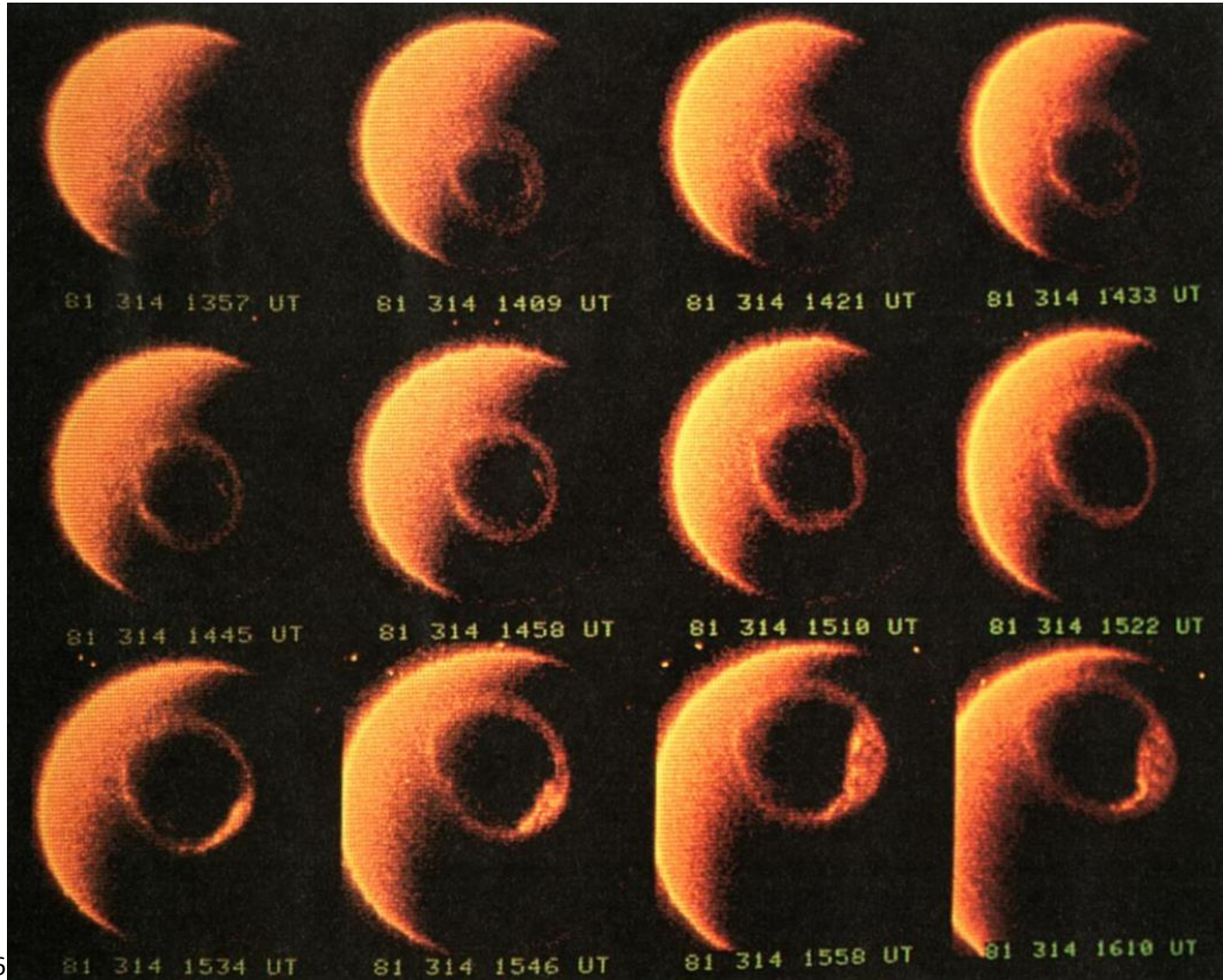
Birkeland currents



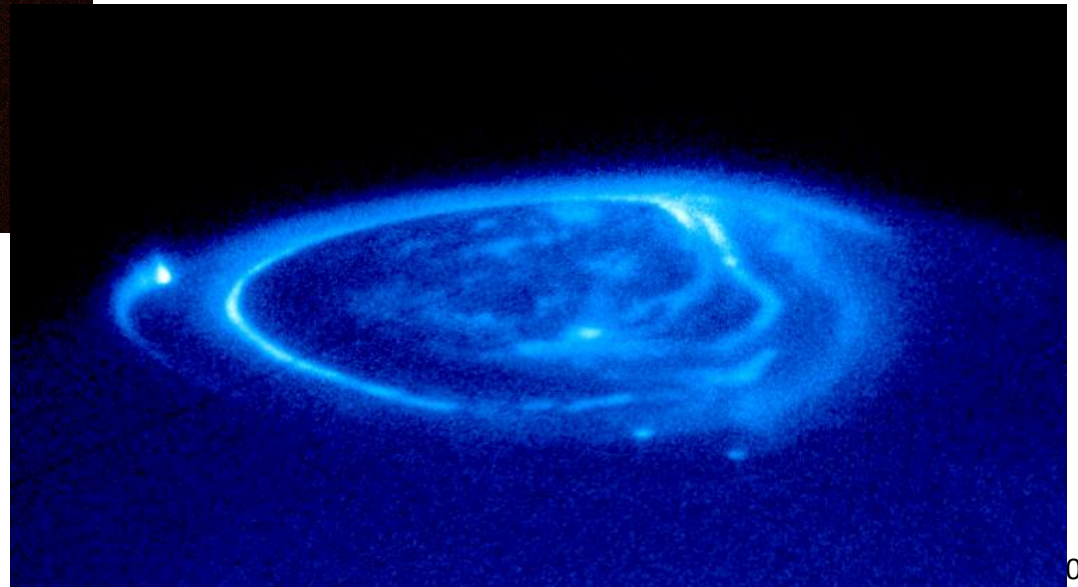
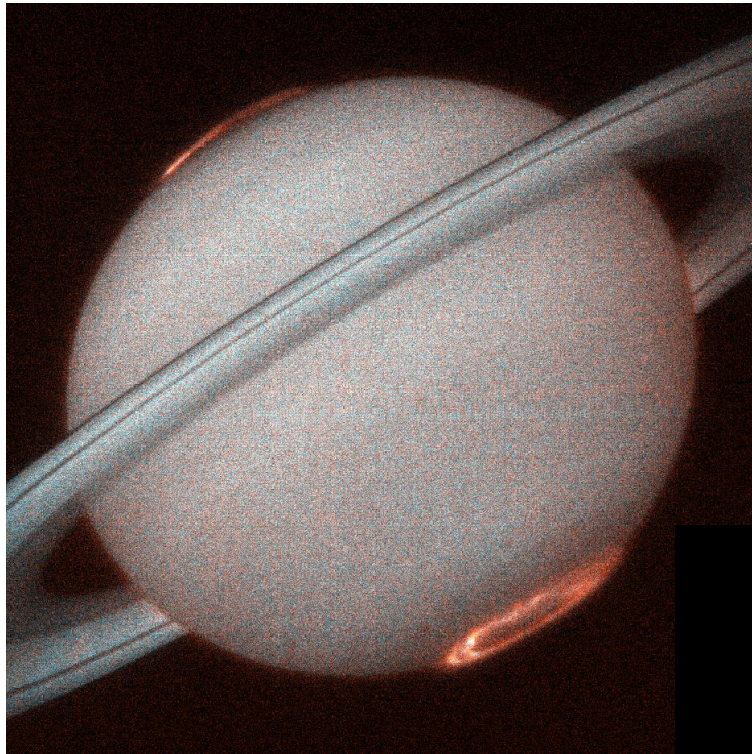
Earth's atmosphere



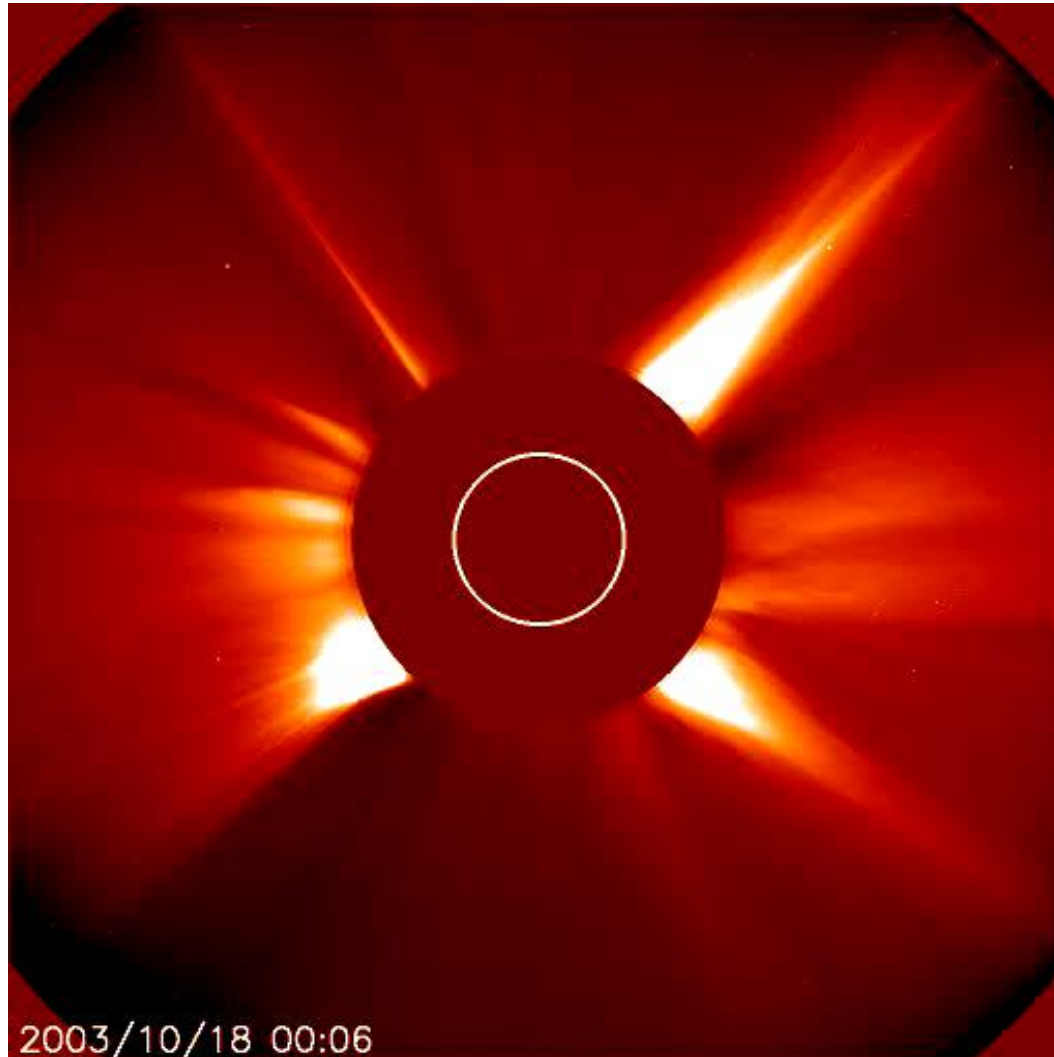
The auroral oval



Aurora on other planets

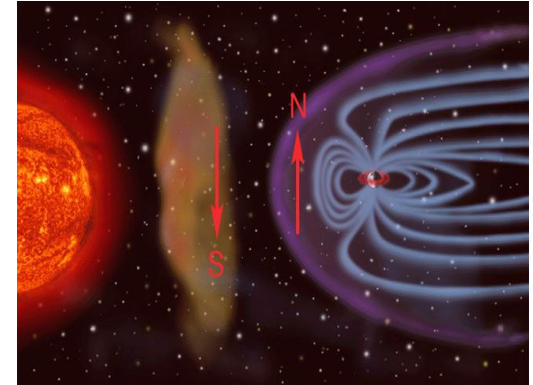


Halloween storm, October 2003

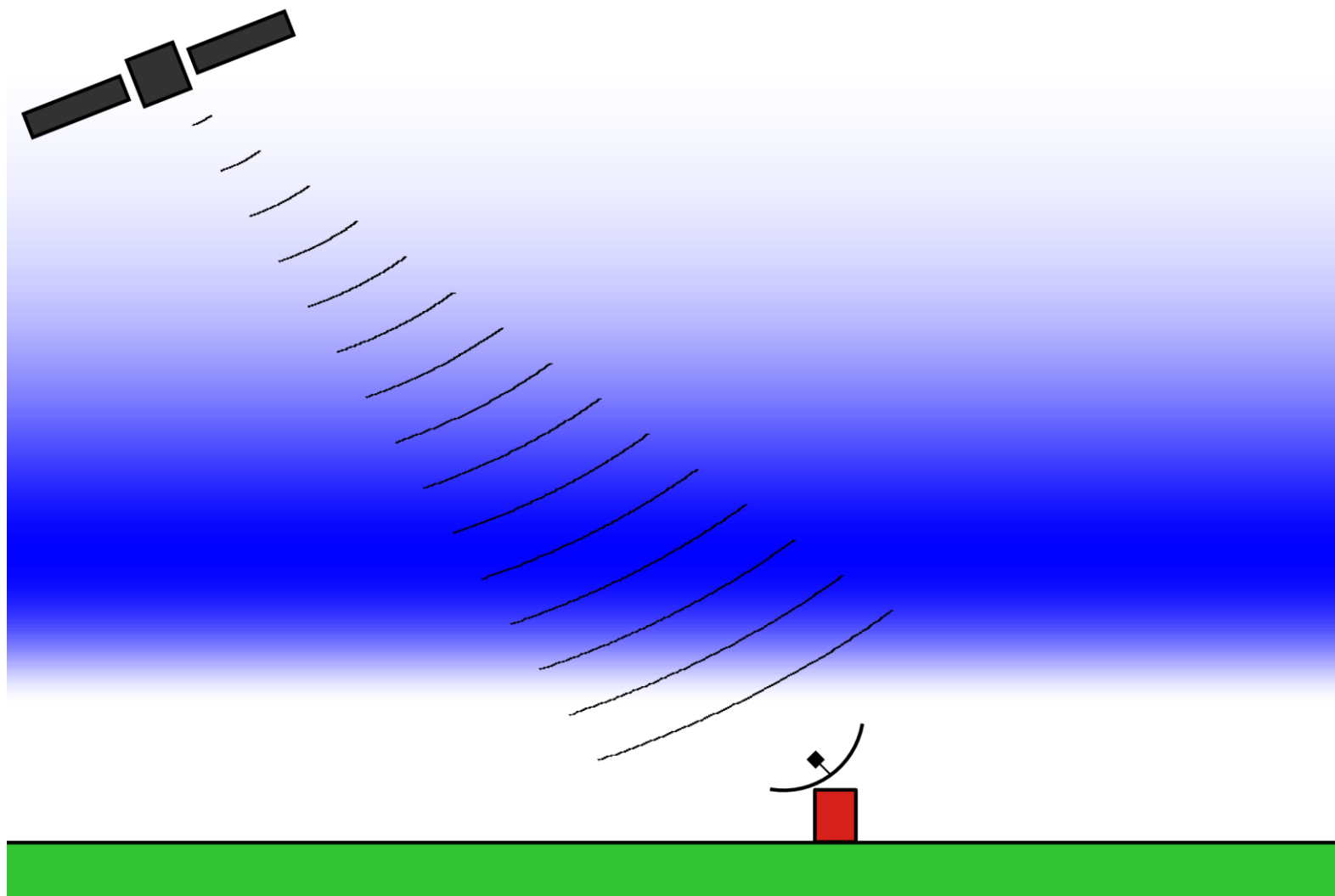


Halloween storm, October 2003

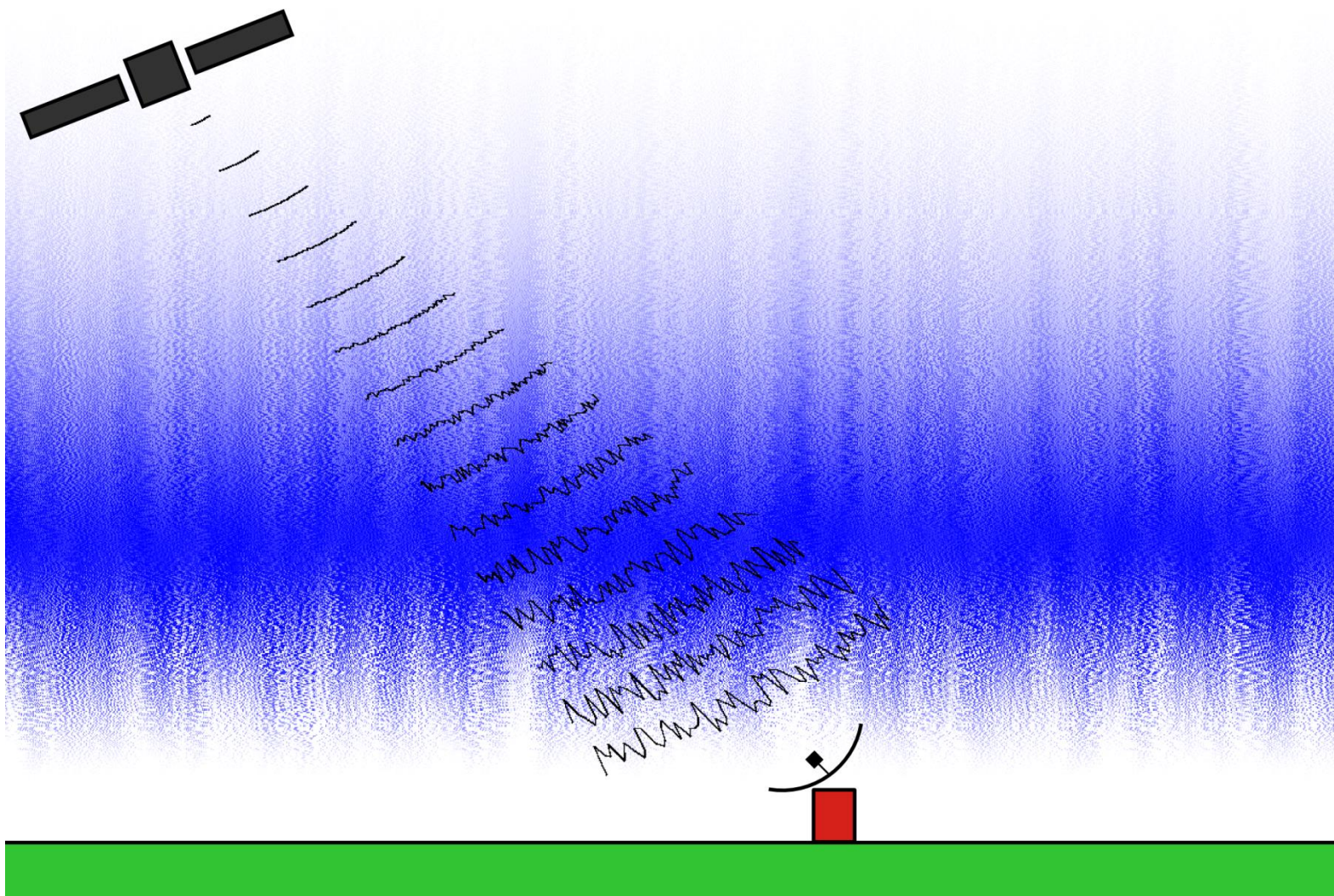
- Aircrafts communication systems at HF/VHF suffered severe degradation and periods (over 130 hours) of blackout
- Trans-polar flights were re-routed to avoid radiation hazards
- More than 20 satellites were affected; one Japanese satellite lost
- Astronauts on ISS had to move into service module for radiation protection
- FAA issued first-ever alert on radiation doses received by airplane passengers above 25,000 ft
- Power system failure in Malmo, Sweden (30 October)
- US Coast Guard to temporarily shut down LORAN C navigation system
- WAAS service interrupted over US; high-latitude GPS receiver outages



Ionospheric impact



Ionospheric impact



Similar example

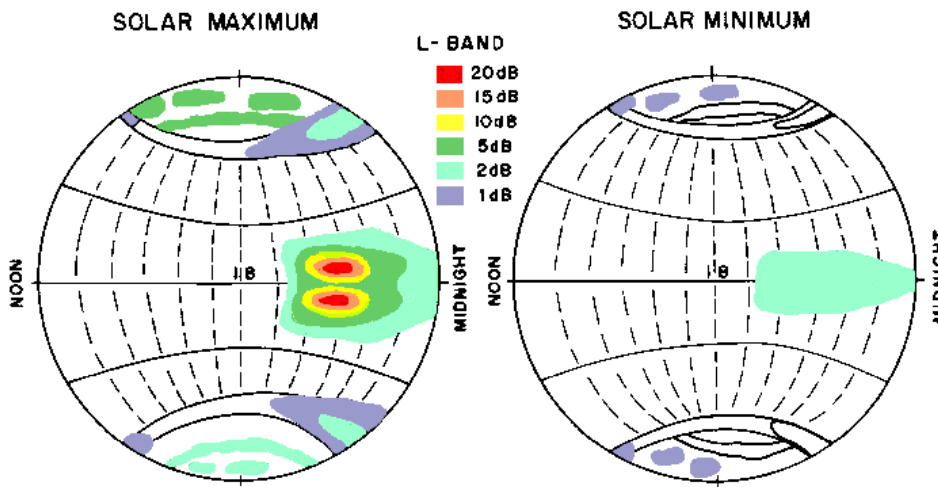
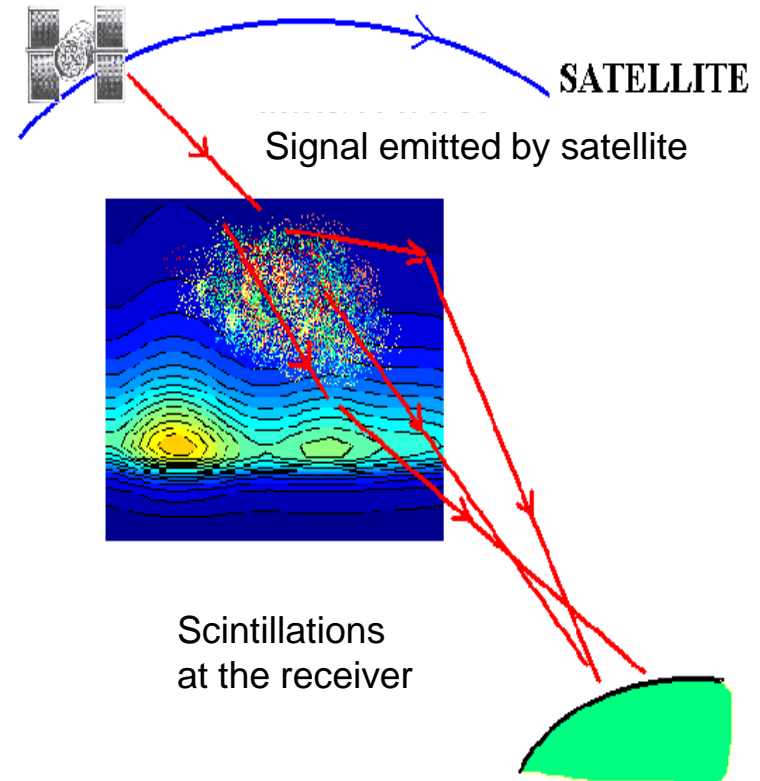


Similar example



Space weather

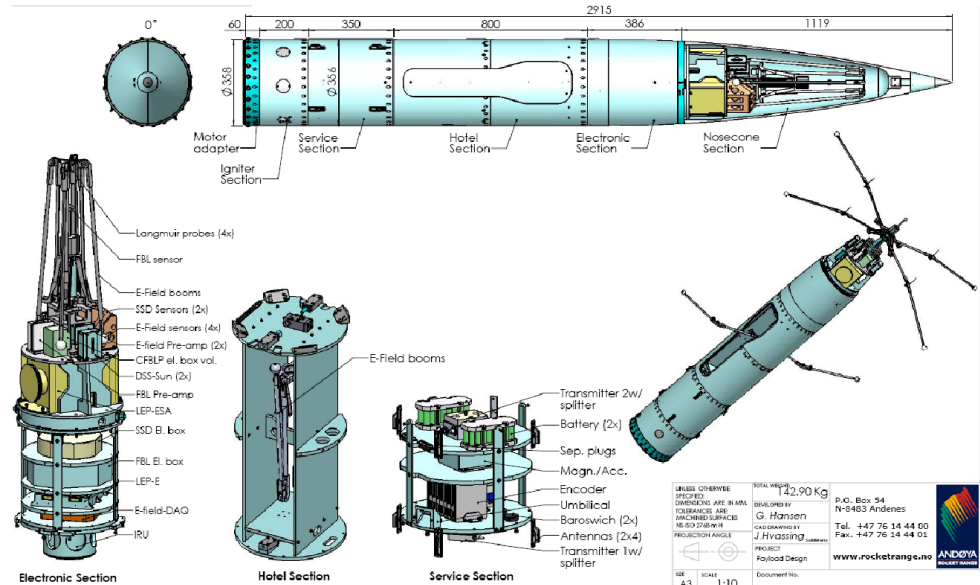
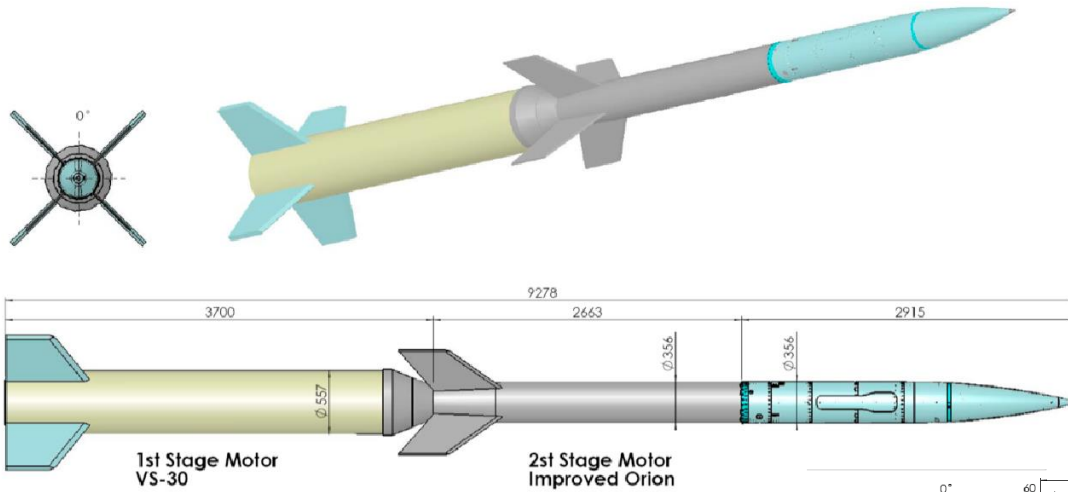
- Ionospheric irregularities produce fluctuations in radio waves, called scintillations
- Severe amplitude fading and strong phase scintillation affect the reliability of GPS systems and satellite communications.



The scintillations occur mainly at polar, auroral and equatorial regions; more frequently around the solar maxima



ICI rocket



ICI so far

ICI 1 - 2003: failed

ICI 2 - 05/12/2008: Success!

ICI 3 - 01/12/2011: Success!

ICI 4 - 19/02/2014: Success!

ICI 5 - Winter 2016

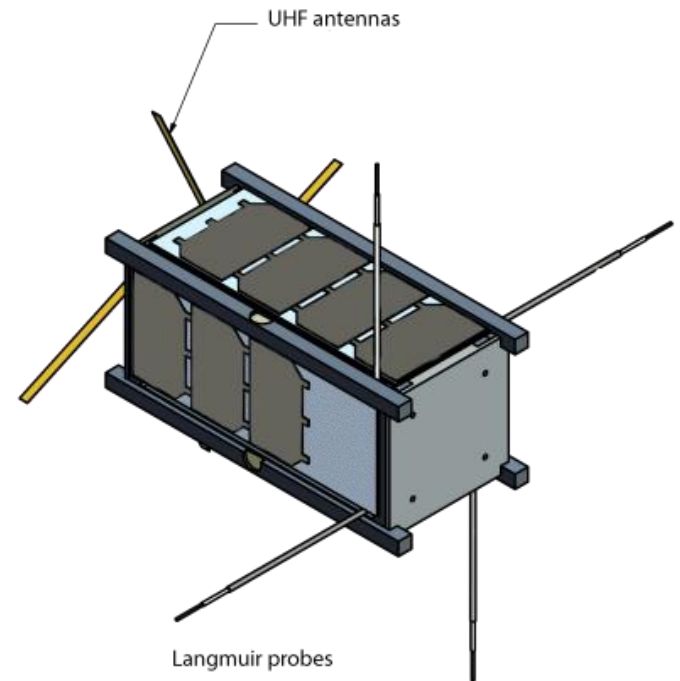
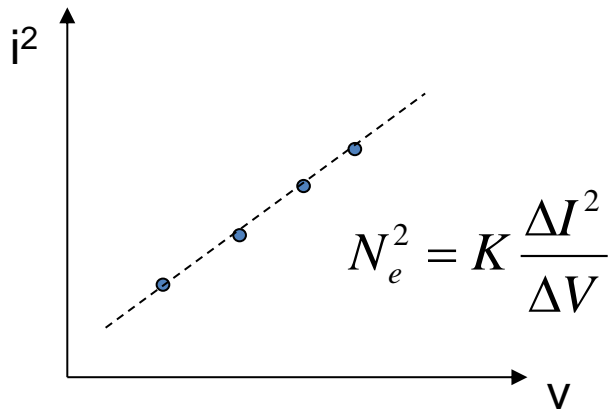
All rockets launched from
Svalbard (except ICI 4 from
Andenes)



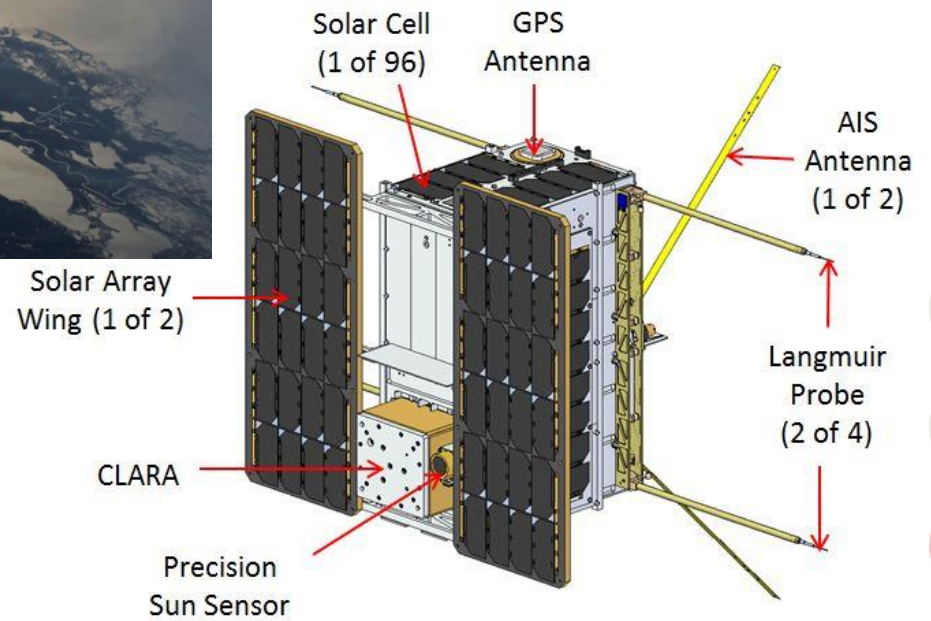
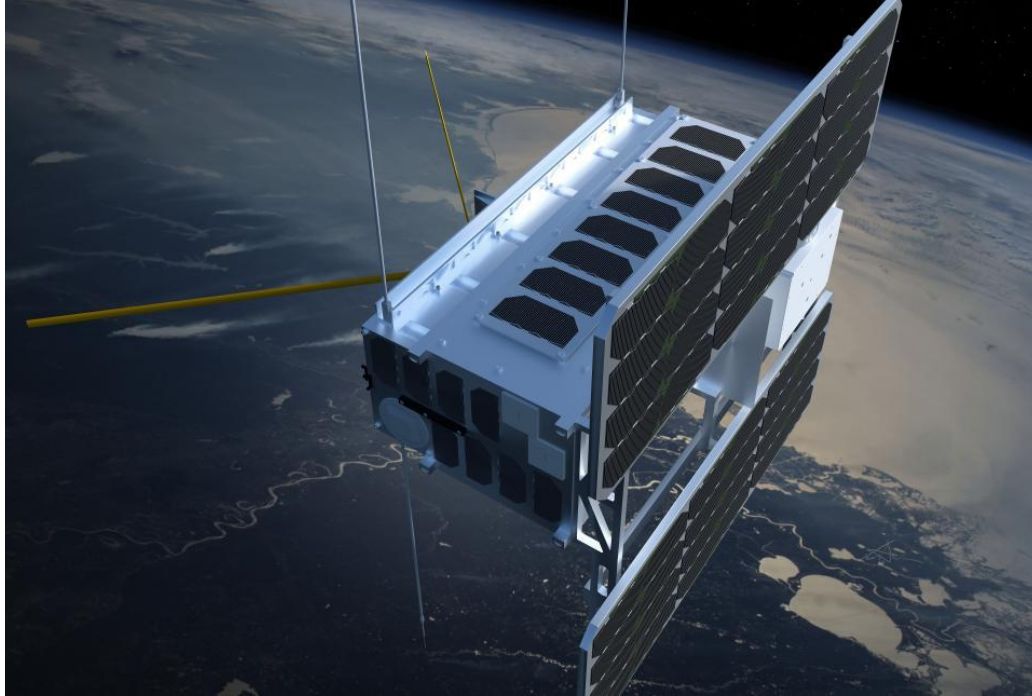
CubeSTAR – a space weather satellite

UiO's Langmuir probe concept: m-NLP
(Multiple Needle Langmuir Probes)

Achieve meter resolution instead km
resolution of electron density
structures



NORSAT 1



UiO in space

- Cluster
- Rosetta
- Bepi-Colombo
- ICI series of sounding rockets
- CubeSTAR
- NORSAT 1
- Student rockets



Study on Svalbard



8/23/2016



CaNoRock

- Canadian Norwegian Student Sounding Rocket Program (2011 – 2021)
- CaNoRock STEP 2012-2016 Exchange opportunities with
 - U. of Alberta, Edmonton
 - U. of Saskatchewan, Saskatoon
 - U. of Calgary, Calgary

