



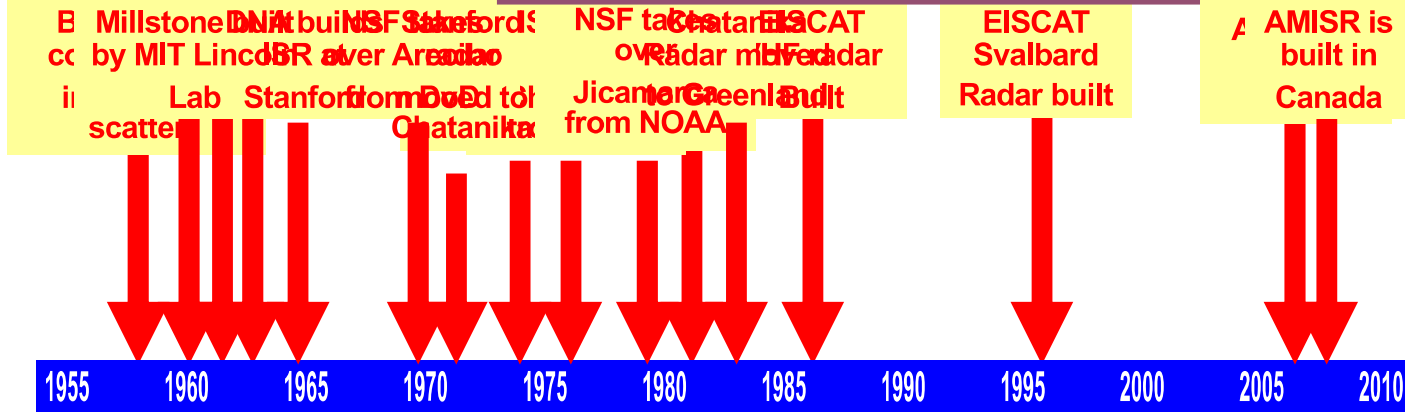
«A History of Space Physics»

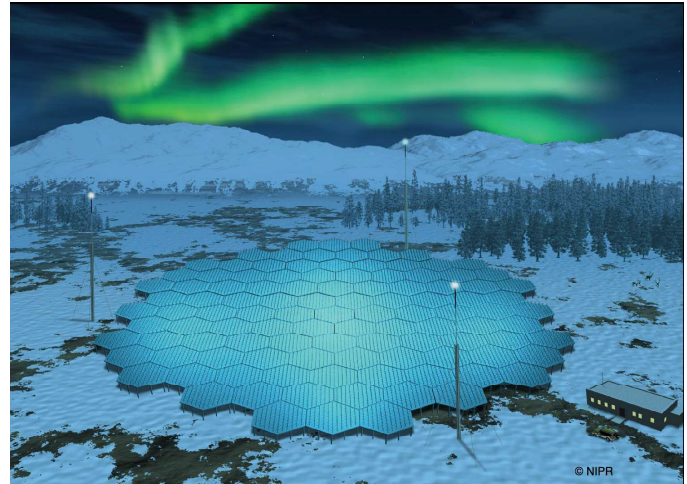
Anja Strømme

anja.stromme@spacecentre.no

Disclaimer:

- 1) History is subjective
- 2) History is biased
- 3) History is about what is left out as much as what is told
- 4) History is constantly rewritten through history
- 5) History often tells us more about the present than the past





**EISCAT-3D
is built in
Scandinavia**

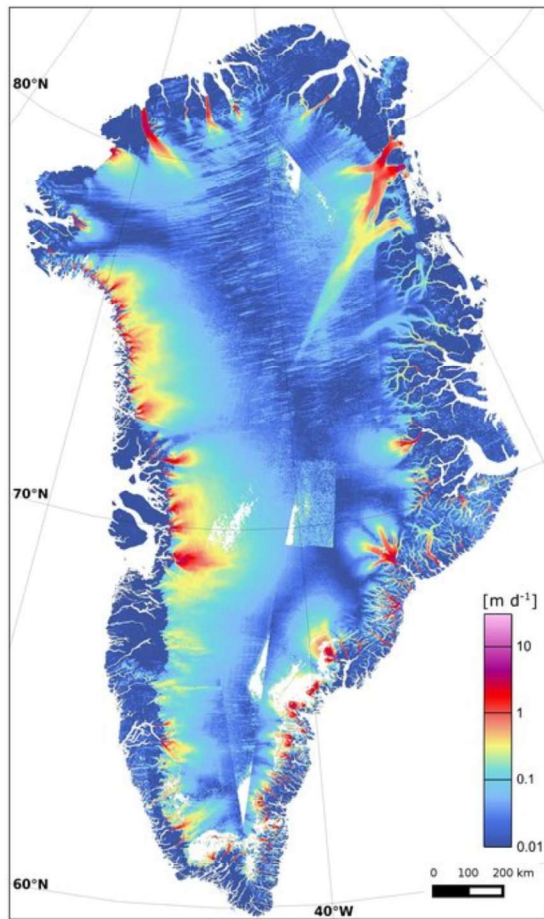


1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010



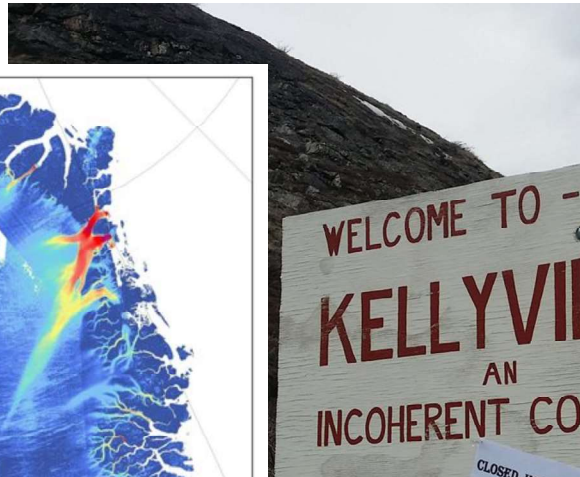
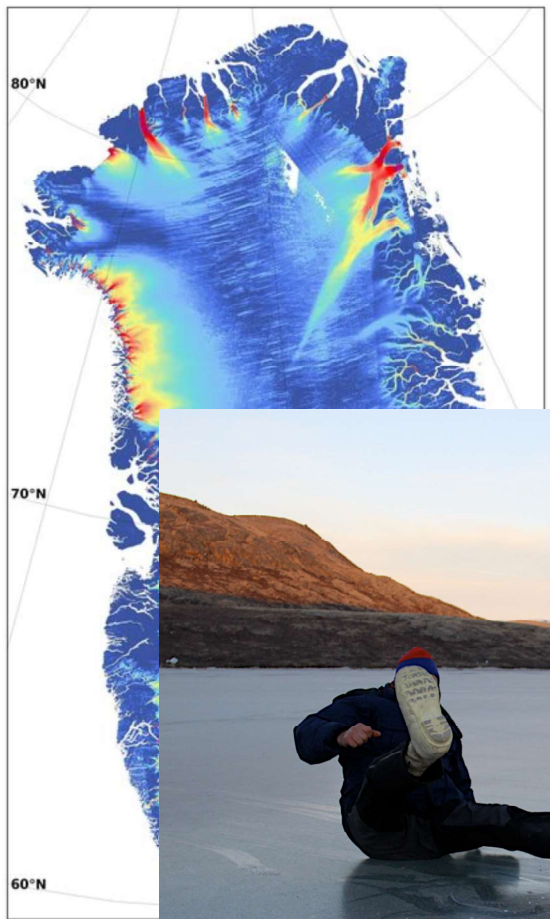
NSF closes
Sondrestrom





NSF closes
Sondrestrom





NSF closes
Sondrestrom



1955

1990 1995 2000 2005 2010

«As you know, the US is under a lot of flux lately. And everyone here feels it, for the good or for the bad. As a graduate student in these times it is difficult to pull up one's sleeves and continue working. That's where you come in.»

«As you know, the US is under a lot of flux lately. And everyone here feels it, for the good or for the bad. As a graduate student in these times it is difficult to pull up one's sleeves and continue working. That's where you come in.»



"Yeah, shoulda done more research before you got me to do this.» Michelle Wolf 2018 White House Correspondents Dinner

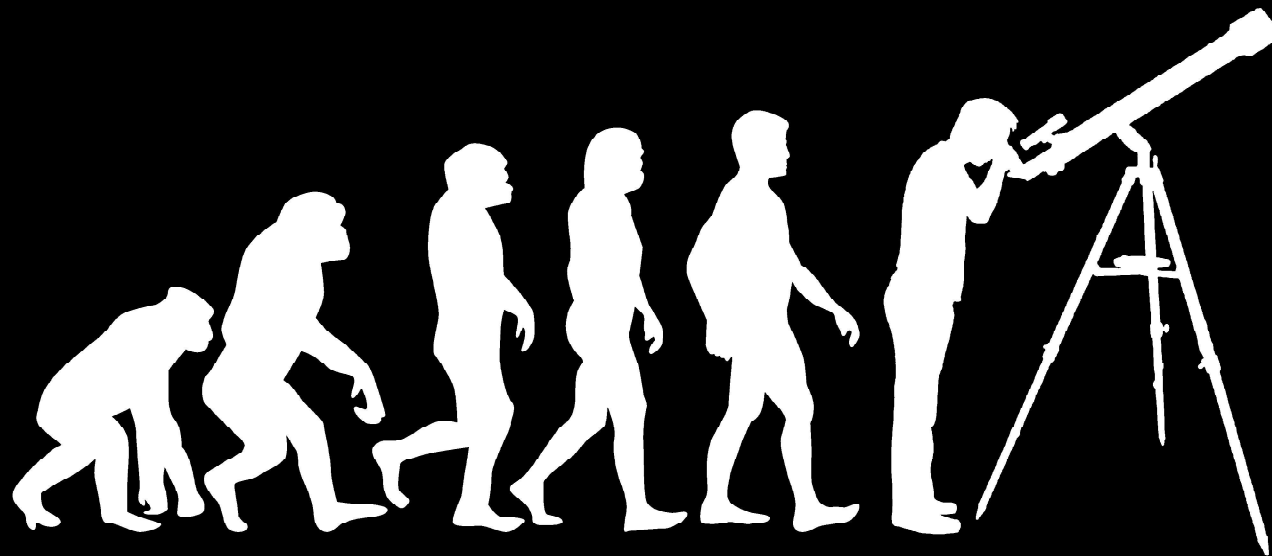


«A few subjectively and somewhat randomly selected examples from the distant and near past that might or might not have any relevance for the current understanding of space science, the future of space science and for the points I want you to leave with today»

Anja Strømme

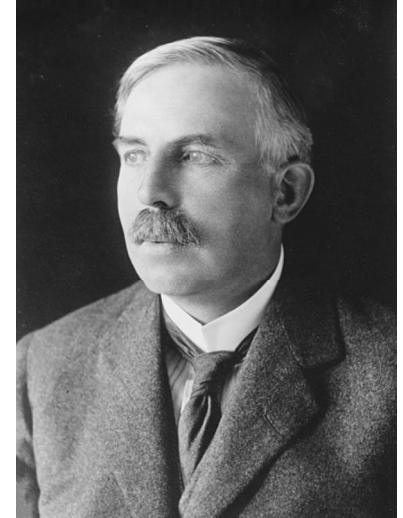
anja.stromme@spacecentre.no

The beginning of space science



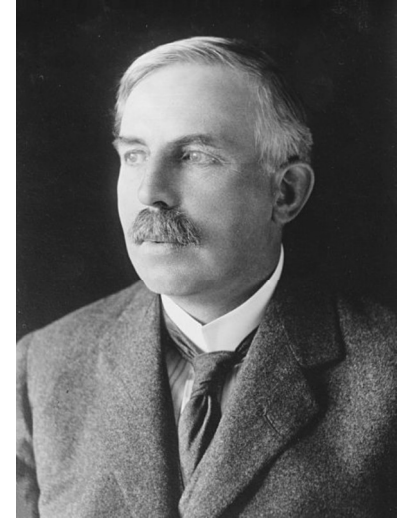
Ernest Rutherford (1871 - 1937)

«That which is not measurable is not science»

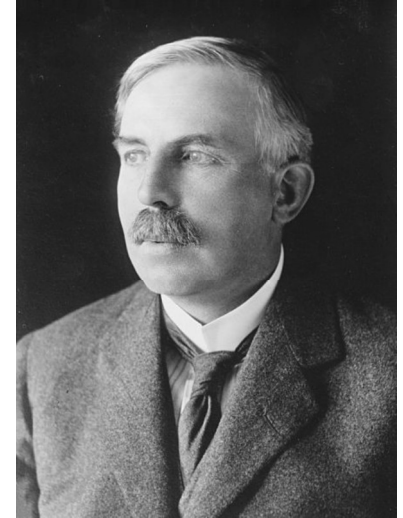


Ernest Rutherford (1871 - 1937)

«That which is not measurable is not science. That which is not physics is stamp collecting»

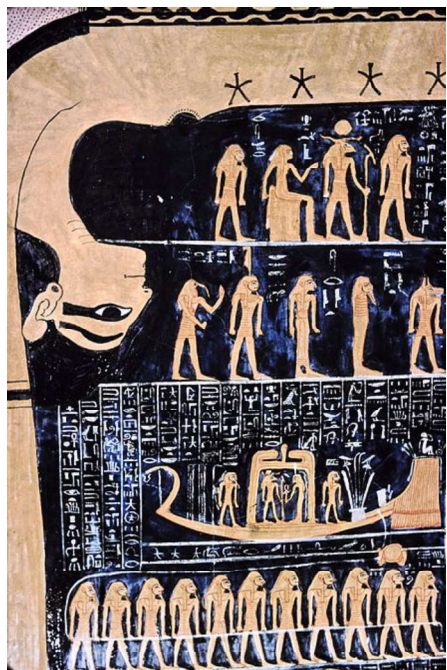


Ernest Rutherford (1871 - 1937)



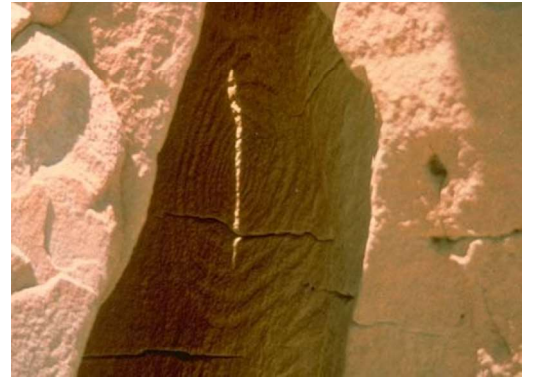
«That which is not measurable is not science. That which is not physics is stamp collecting»

«If your experiment needs statistics, you ought to have done a better experiment.»



Ancestral Puebloans/Anasazi space science

The Sun dagger of Chaco Canyon



Scientific Renaissance 1450–1630

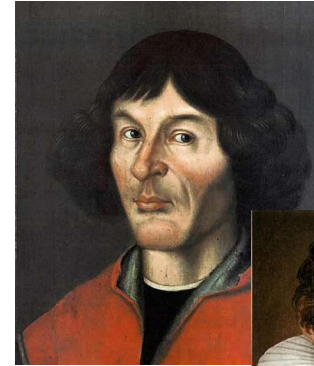
Nicolaus Copernicus (1473 - 1543)

NICOLAI COPERNICI TORINENSIS
DE REVOLUTIONIBUS ORBIS
UM COELESTIUM, Libri VII.

Habes in hoc opere iam recens nato, et edito,
studiosè lector, Motus stellarum, tam fixarum,
quam errantium, cum ex ueritatibus, tum etiam
ex recentibus observationibus relictis: et mo-
tis indeper ac admirabilibus hypothesebus oer-
natis. Habes etiam Tabulas expeditissimas, ex
quibus eodem ut quodvis tempore qualem facili-
ter calculare poteris. Igitur eme, lege, fructe.

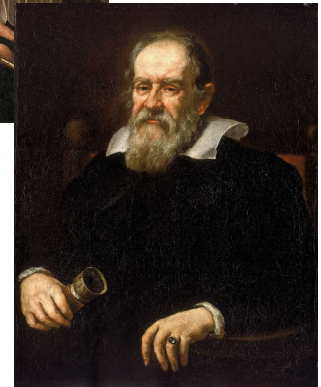
Exemplum huius libri.

Notimburgæ apud Joh. Petrusium,
Anno M. D. XLIII.



Johannes Kepler (1571 – 1630)

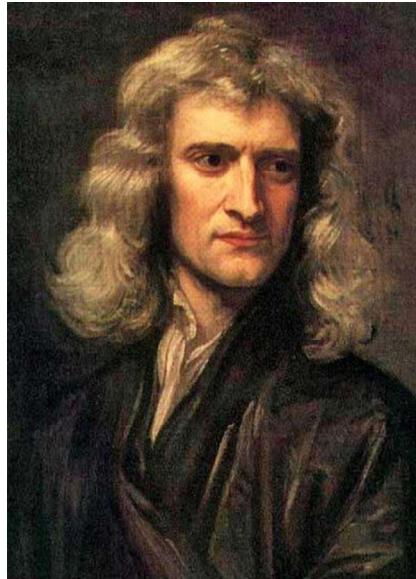
Galileo Galilei (1564-1642)



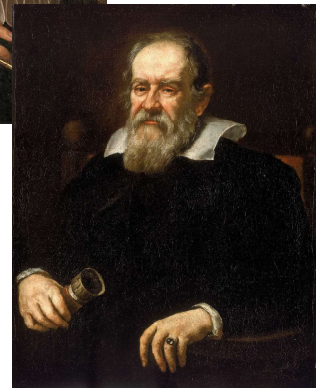
Eppur si muove – «and yet it moves»

Scientific Renaissance 1450–1630

Isaac Newton 1642 - 1727

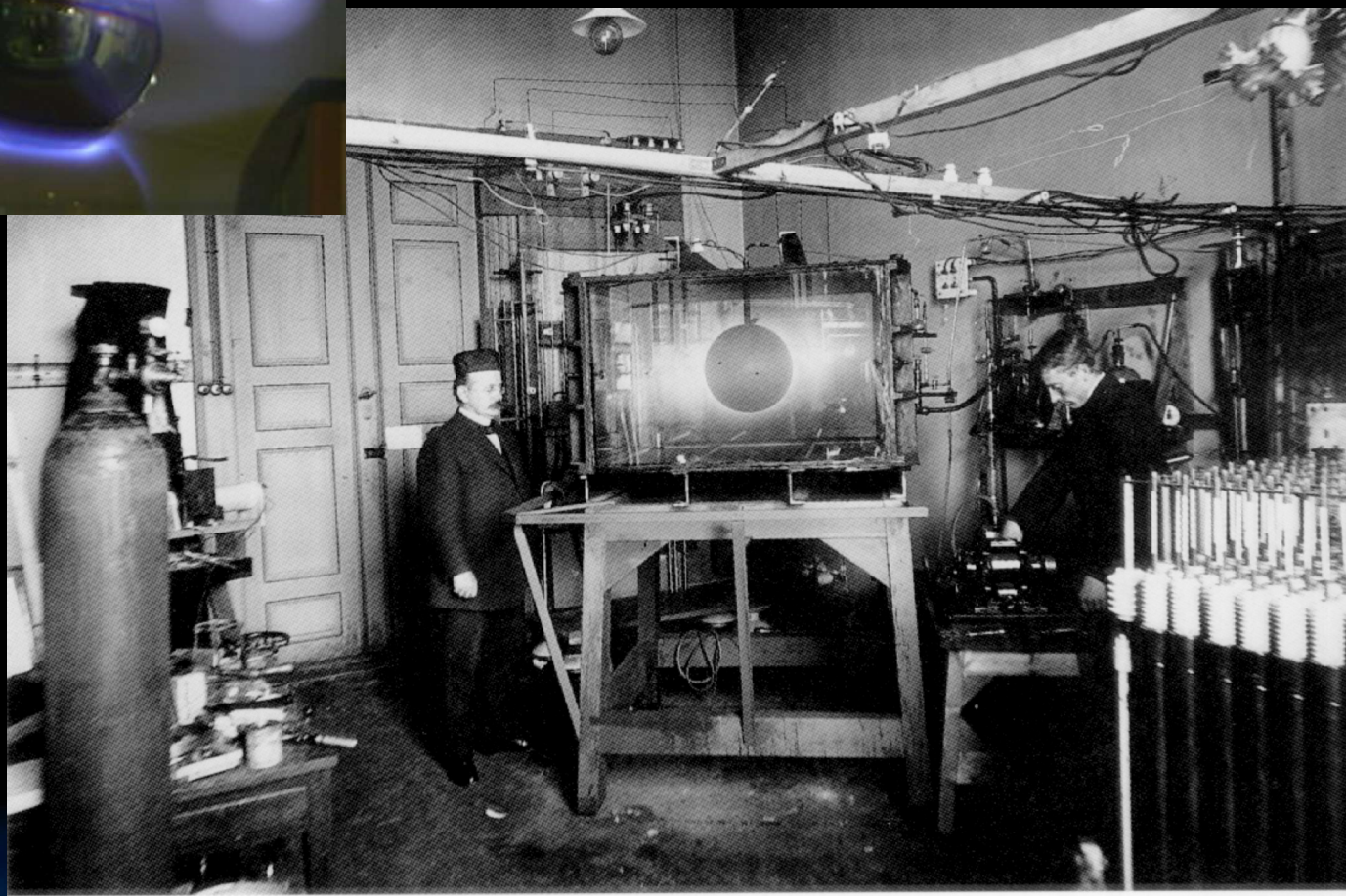


"If I have seen further it is by standing on the shoulders of Giants»"





Kristian Birkeland (1867 - 1917)

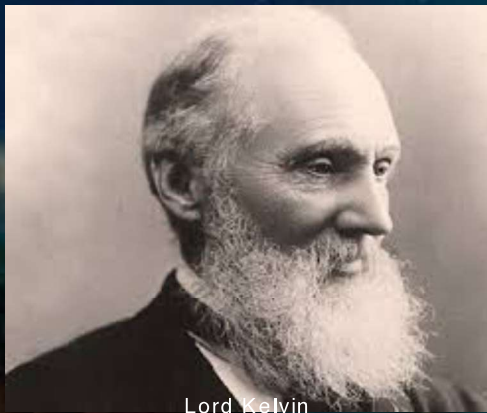


Birkeland - criticised by fellow scientists

Birkeland's theories about the northern lights and electrical currents in the atmosphere met great opposition among internationally renowned scholars such as Lord Kelvin and British scientist Sydney Chapman.

Lord Kelvin argued it was not possible that the Sun was responsible for the aurora - since space was «empty»

Chapman said that Birkeland expeditions to the arctic was unnecessary and his theory too «curious».



Lord Kelvin



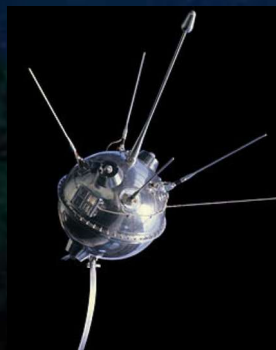
Sydney Chapman

Satellites Confirm Birkeland Theories

In 1959 the Russian Luna I measured solar wind particles on the way to the moon. In 1962 NASA's Mariner II spacecraft on its way to Venus measured the presence of an electrified gas with speed up to 300-700 km/s. This proved that «empty» space was not empty at all but filled with particles - the solar wind

In 1966 a U.S. Navy navigation satellite observed magnetic disturbances near polar regions. This lifted Birkeland's name again.

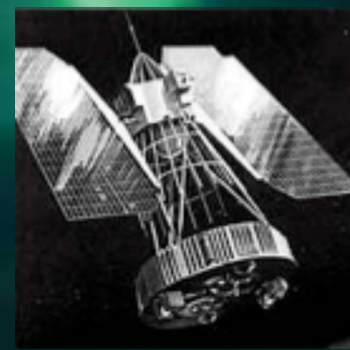
Electrical currents were detected by satellites in 1967 and 1973 just like Birkeland proposed



Luna I

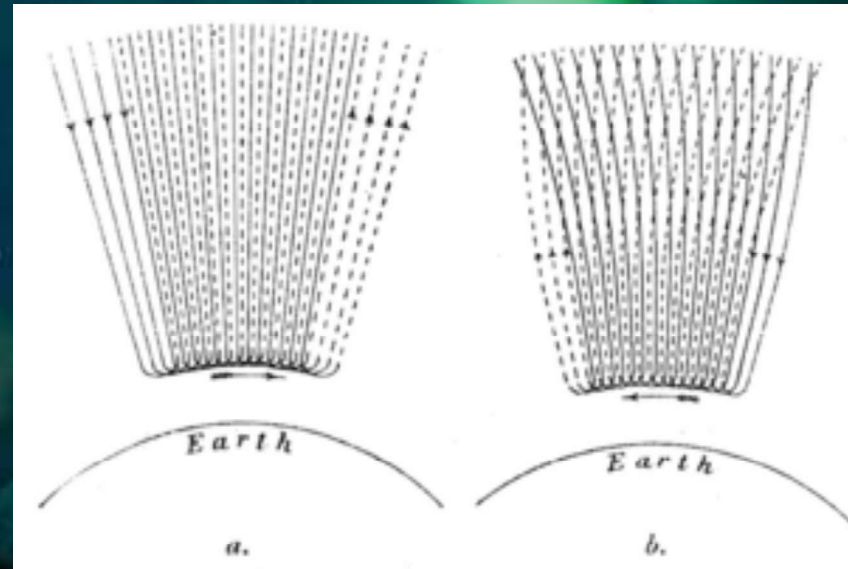
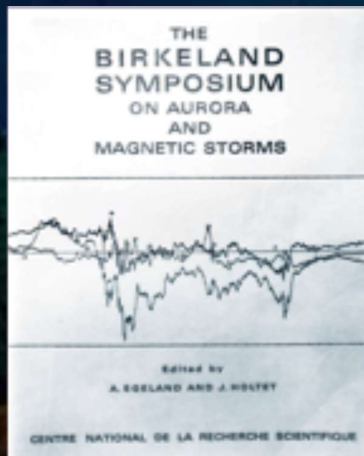


NASA Mariner II



Birkelands first International Acknowledgment

In 1967 a large international symposium was organised in Sandefjord, Norway to celebrate that it was 100 years since Birkeland was born. At this meeting an international committee announced that the currents in the atmosphere should be named Birkeland Currents. This was the first international acknowledgment Birkeland received.



Chapman vs Birkeland

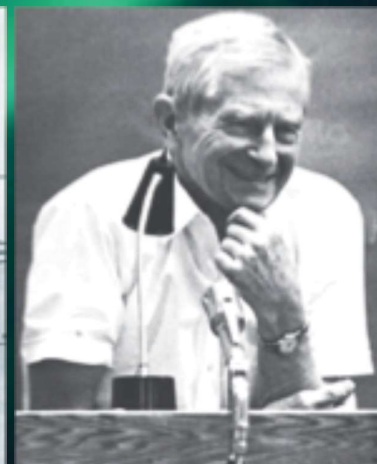
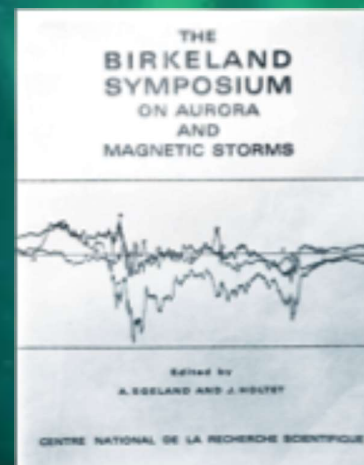
Sydney Chapman was invited to give a keynote lecture the first day. Even here Chapman stated this at a conference:

«Though Birkeland was certainly intensively interested in the aurora.....it must be confessed that his direct observational contribution to auroral knowledge were slight»

One young American scientist, Alex Dessler, questioned Chapman about Birkeland.

«I asked him whether Birkeland work had any influence on him at all»

«How could it? It was all wrong»

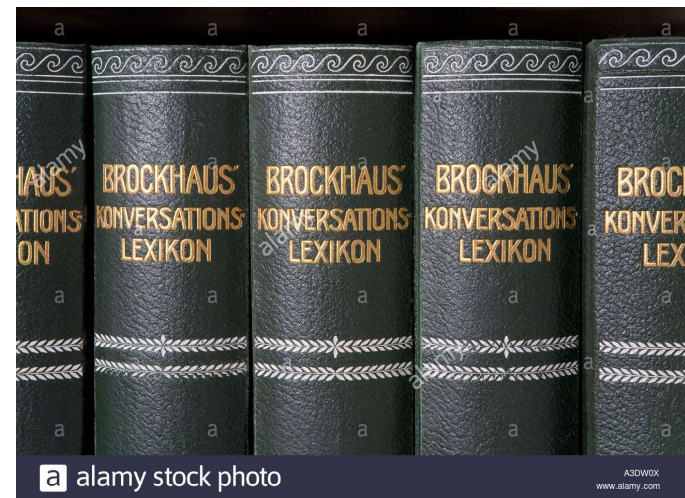
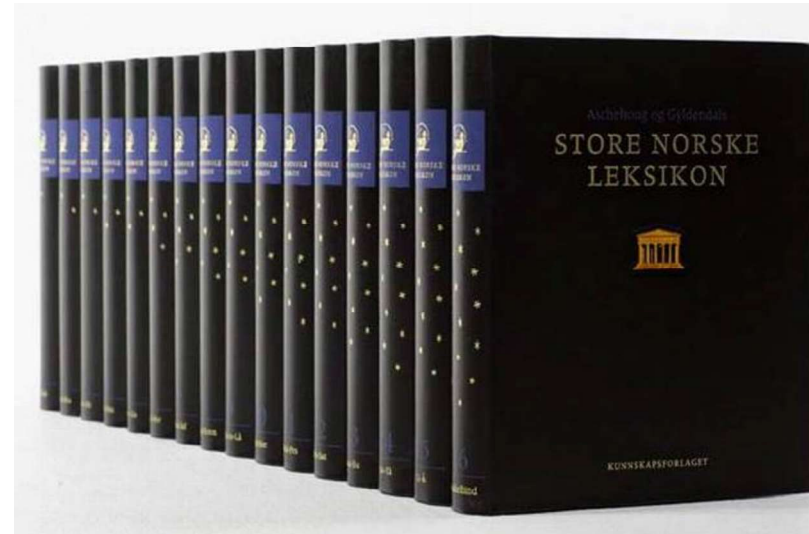
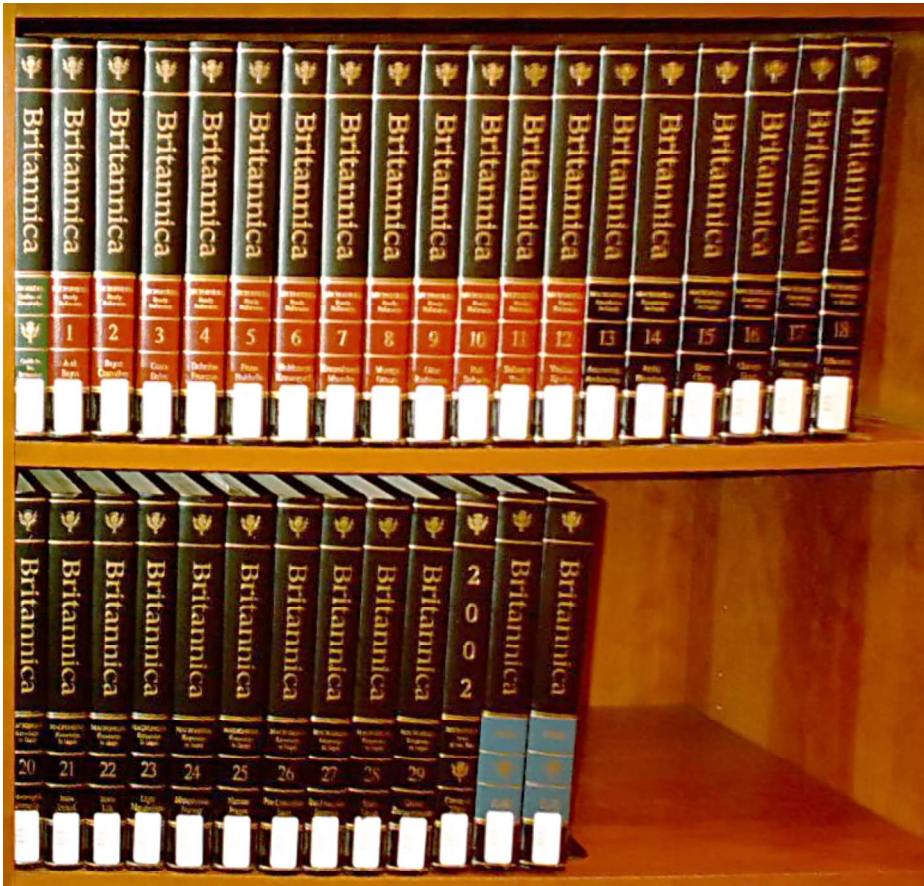


Where do I want to go with this?





Sources of knowledge...



OPENING HOURS

Monday	9.30am to 5pm	Thursday	9.30am to 7pm
Tuesday	9.30am to 5pm	Friday	9.30am to 5pm
Wednesday	9.30am to 5pm	Saturday	9am to 12pm

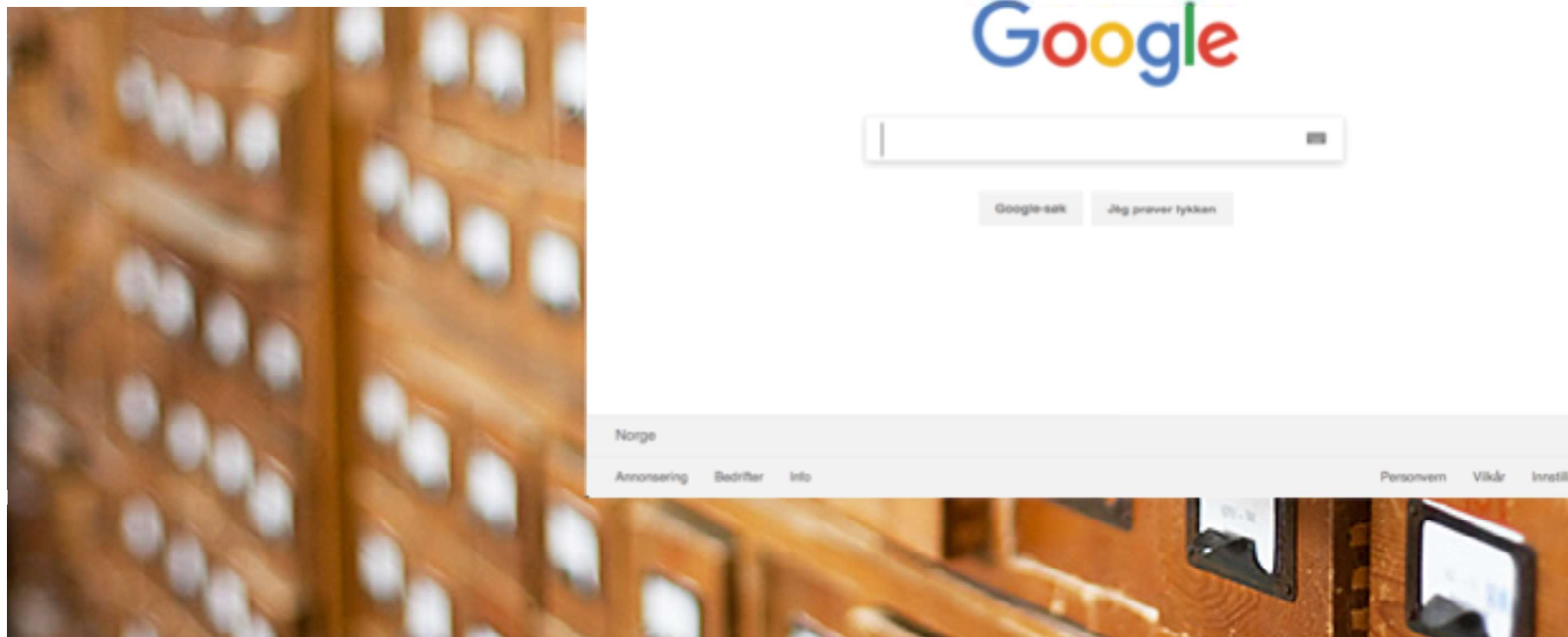
Claremont Community Hub & Library - 327 Stirling Highway, Claremont
Ph: 9285 4353 | Email: library@claremont.wa.gov.au

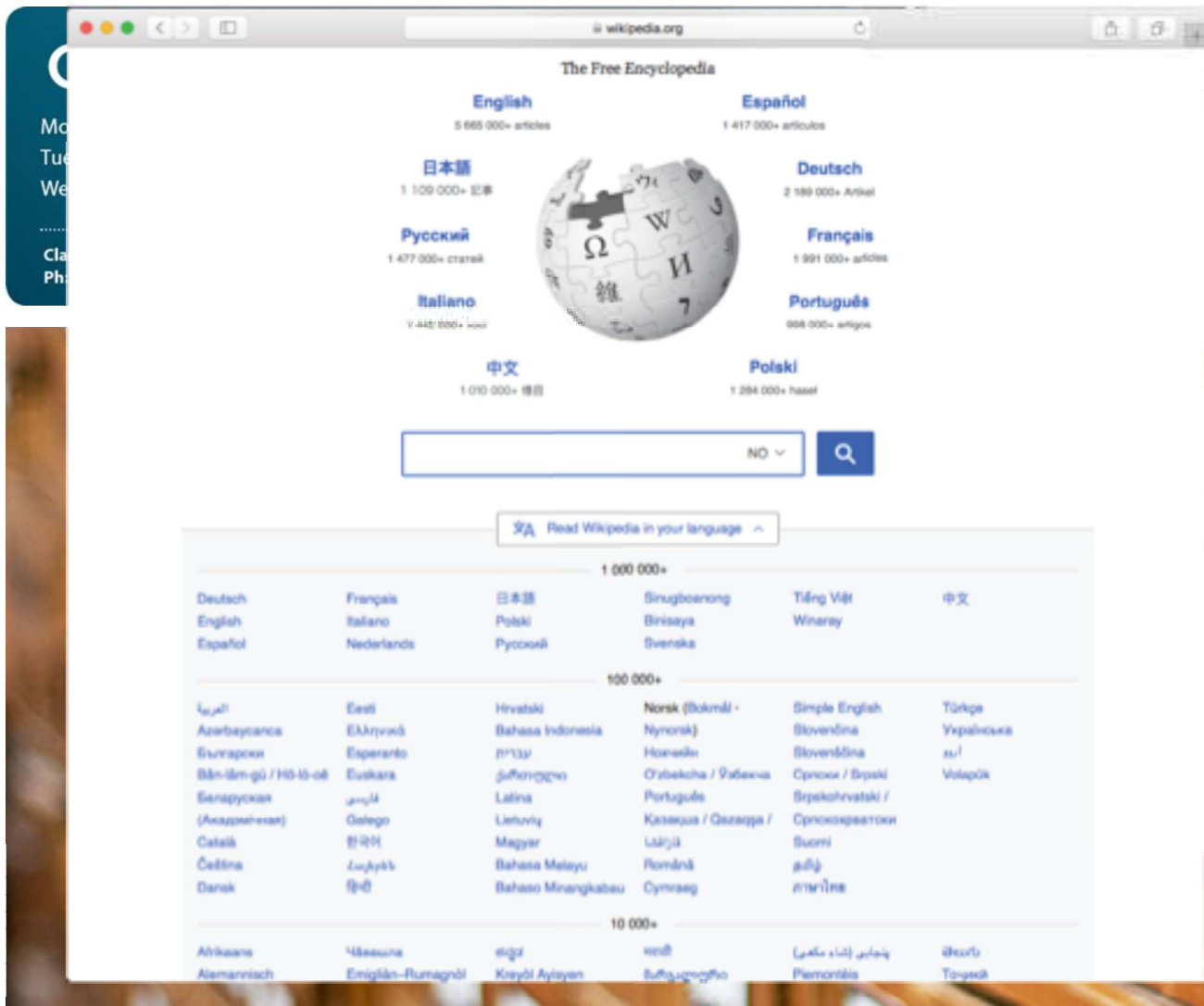


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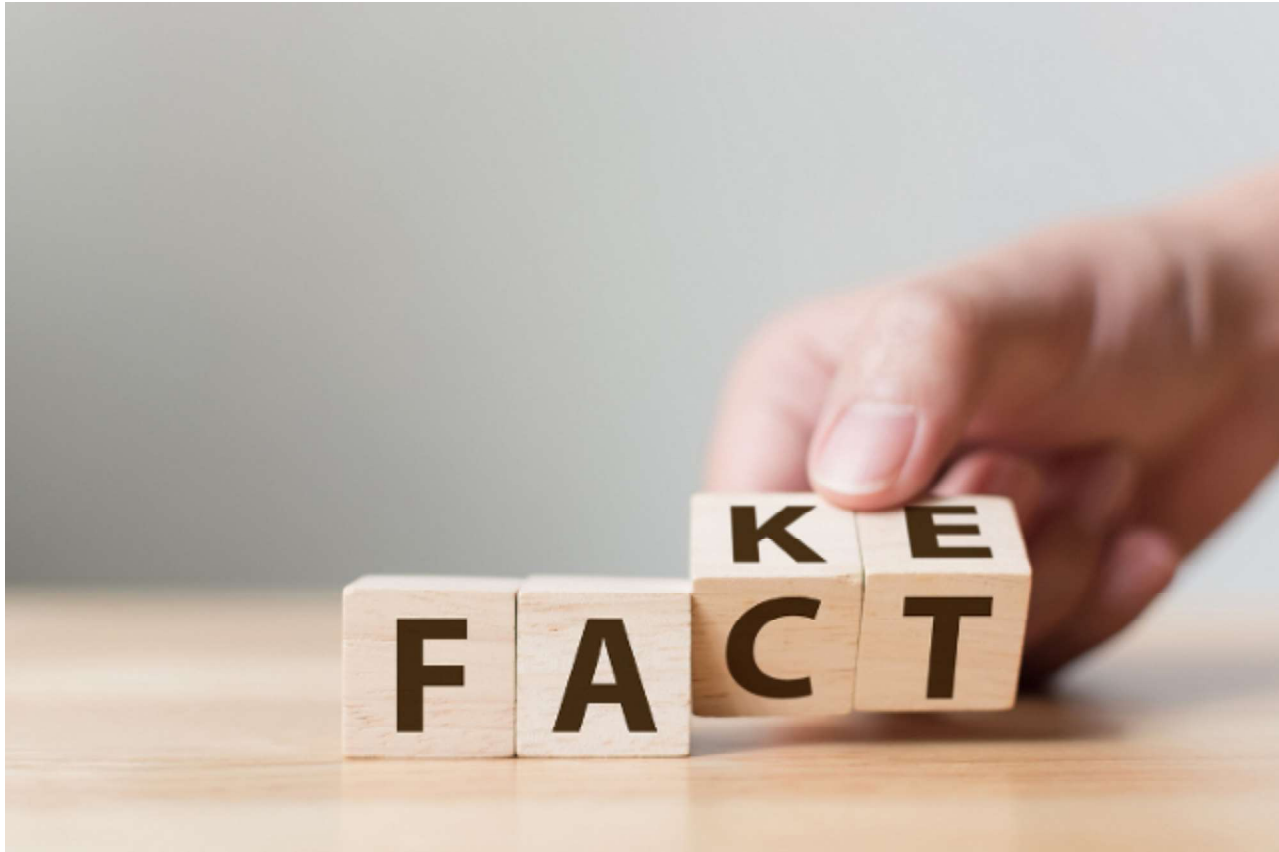
Claremont Community Hub & Library - 327 Stirling Highway, Claremont
Ph: 9285 4353 | Email: library@claremont.wa.gov.au





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With Great Power Comes Great Responsibility



Our classic «inside the box» thinking



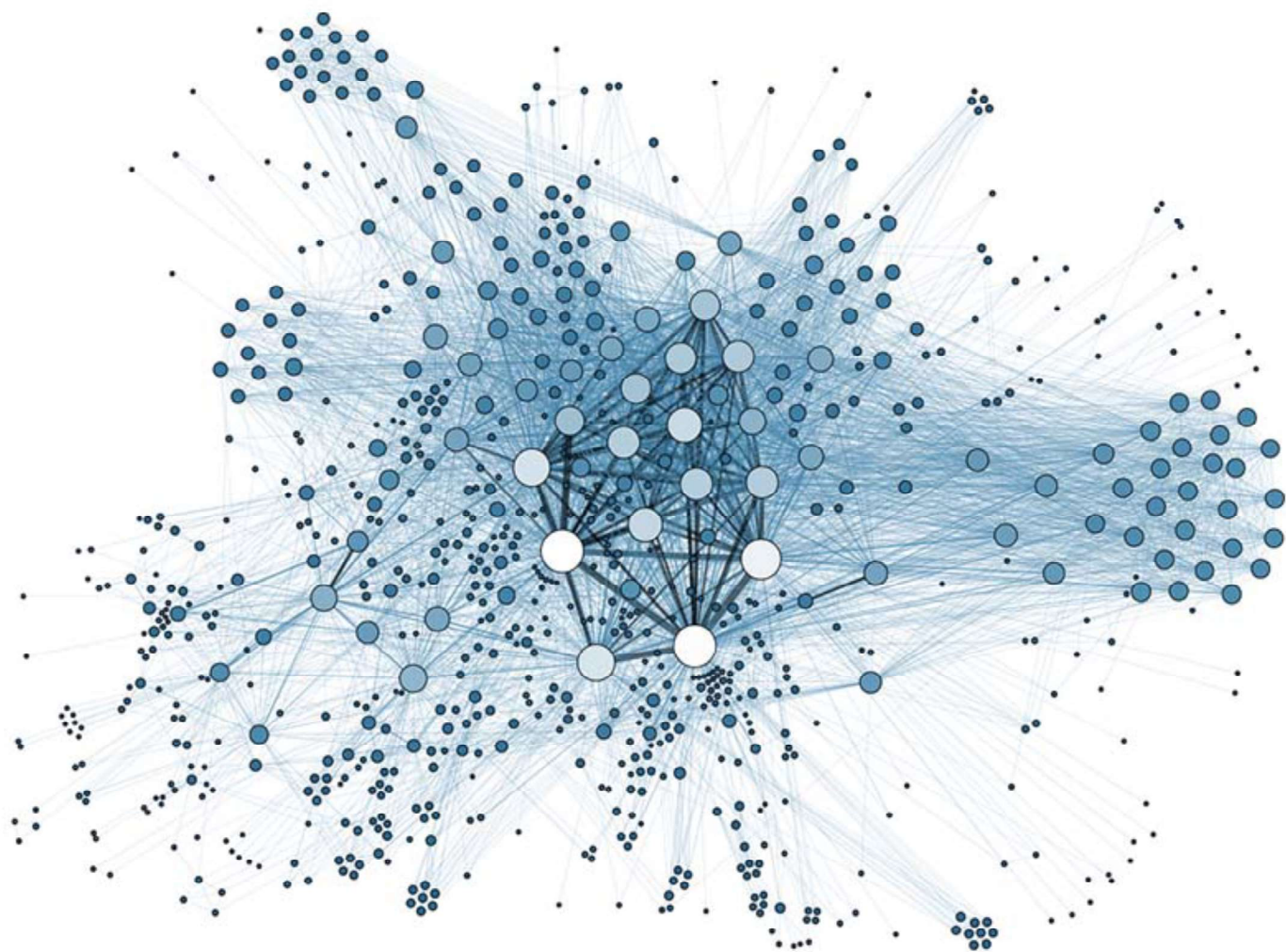
«Outside the box»



We need you to stop thinking outside the box!

We need you to stop thinking outside the box!







One Man – One Instrument
is history



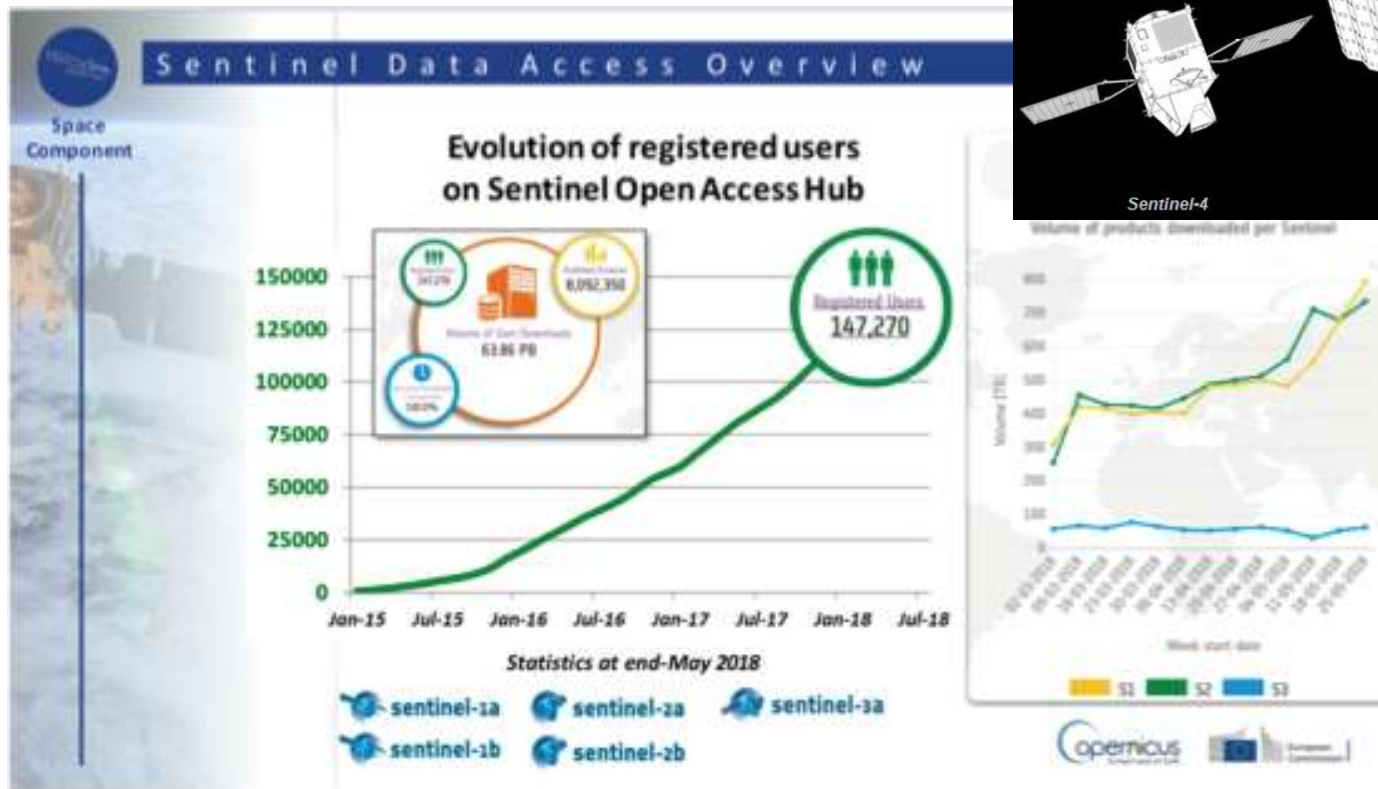
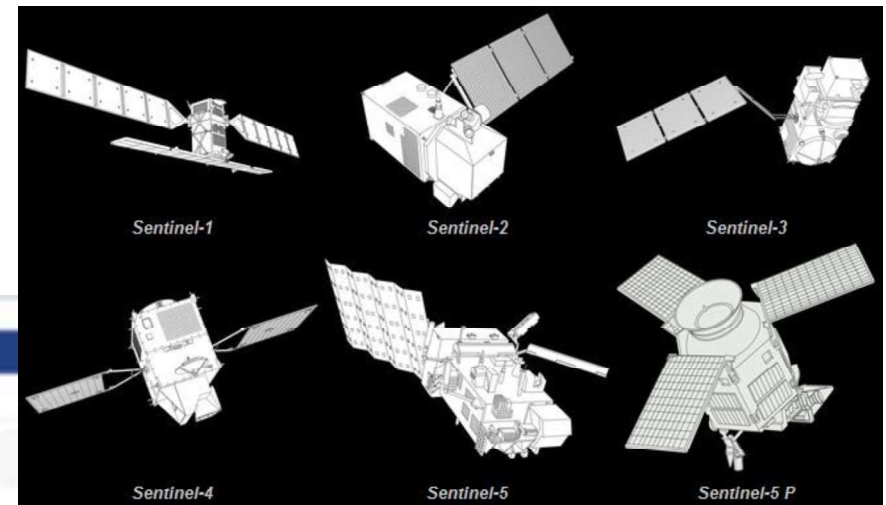
Storing data on disk on your shelf is history



Storing data on disk o



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1010101DATA01010
1011001010110010



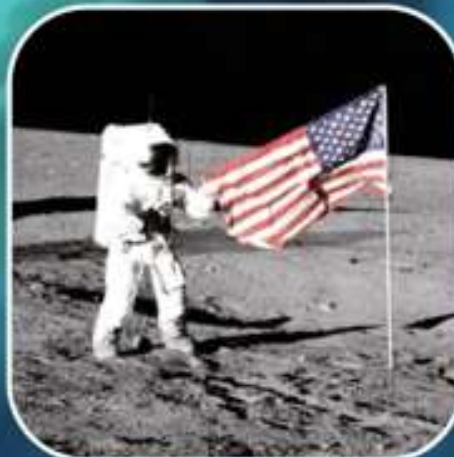
The Space 4.0 Era



Space 1.0

Astronomy

Since millennia



Space 2.0

Space Race

Since 1958



Space 3.0

Int. Cooperation

Since Fall of the Wall



Space 4.0

Space for
Society

Now



European Space Agency

NewSpace – what is it?

2016 Forbes article:

People may not know exactly what 'NewSpace' is. But they know they are excited about it. [...] [T]he spotlight [is] understandably on low-cost and visionary commercial space technologies. But the concept is more than that. [\[15\]](#)

February 2017 [Observer Research Foundation](#) article on NewSpace in India:

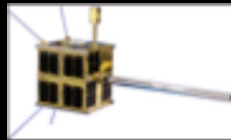
While there is no internationally accepted technical definition of 'NewSpace', principally, the ethos of the movement has been to challenge the traditional ways of space exploration that are widely considered as too expensive, time-consuming, and lacking in room for inventive risk-taking. [\[13\]](#)

According to a [NASA](#) presentation titled "NewSpace: The 'Emerging' Commercial Space Industry»:

We are at a turning point in the history of space exploration and development—the cusp of a revolution, new industries are being born that use space in many different ways [...] The established military industrial space sector is no longer the only game in town [...] Increased competition and new capabilities will change the market place forever [...] Everyone interested in working in the space sector will be [a]ffected. [\[9\]](#)

Source: Wikipedia

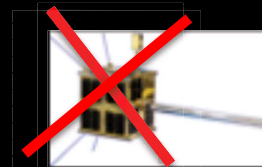
Norwegian small satellites



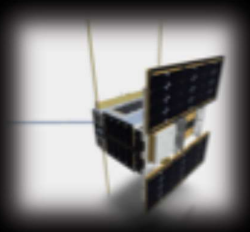
AISSat-1 (2010)
(2010)



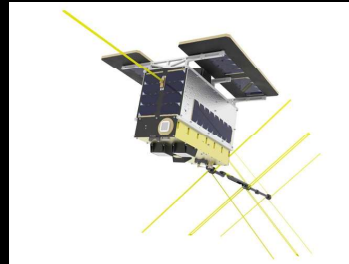
AISSat-2 (2014) (2014)



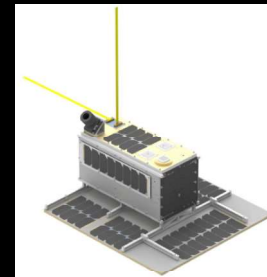
AISSat-3 (Q4 2017)



NorSat-1 (July 2017)
- AIS
- Space weather
- Solar TSI



NorSat-2 (July 2017)
- AIS
- VDES demonstrator



NorSat-3 (Q4 2019)
- AIS
- Navigation radar detector

NorSat-1 and NorSat-2 launch 14th July 2017

Separation from Soyuz at **11:01:45**



Commercial «Cargo truck» to ISS

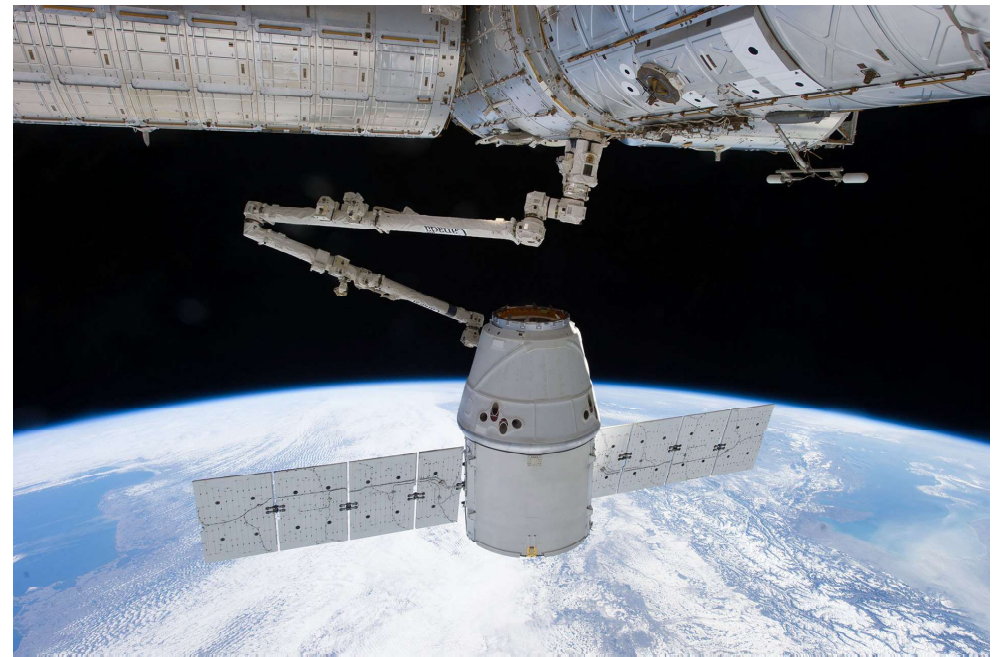


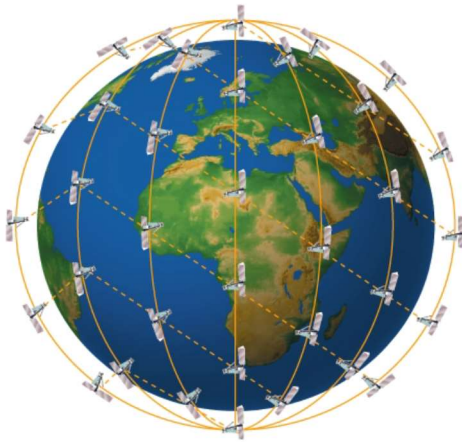
The SpaceX Dragon CRS variant approaching the [ISS](#) during the [C2+](#) mission in May 2012.

Commercial «Cargo truck» to ISS



The SpaceX Dragon CRS variant approaching the [ISS](#) during the [C2+](#) mission in May 2012.





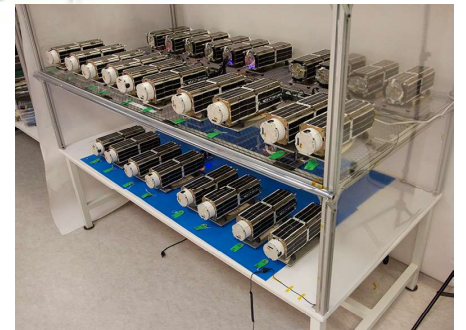
Iridium and Ampere



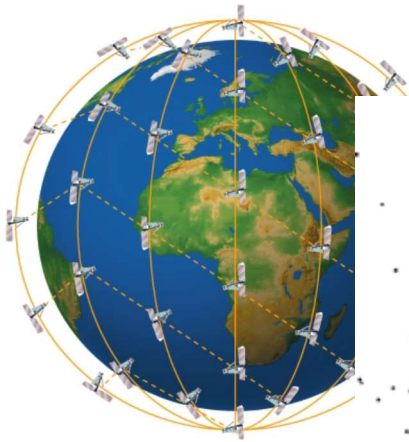
OneWeb



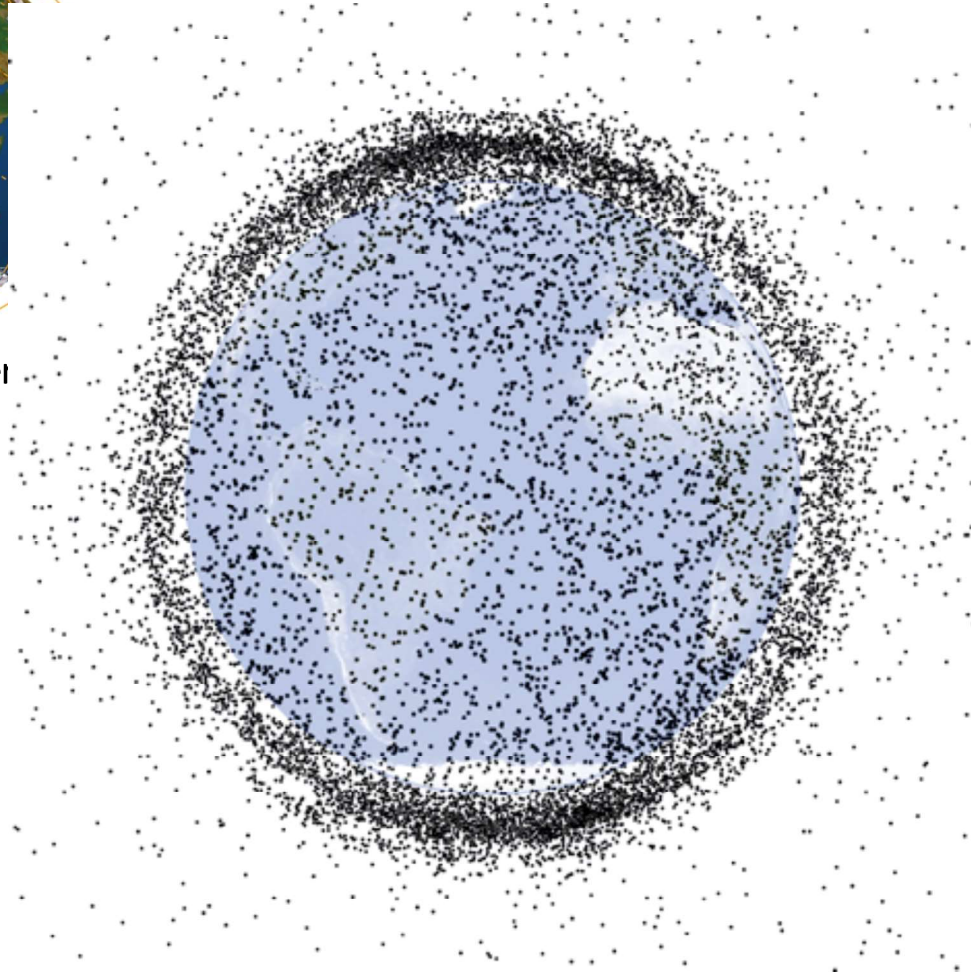
Iceye/MicroSAR etc



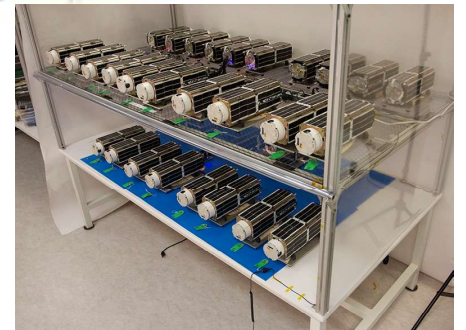
Planet Doves



Iridium and Amper



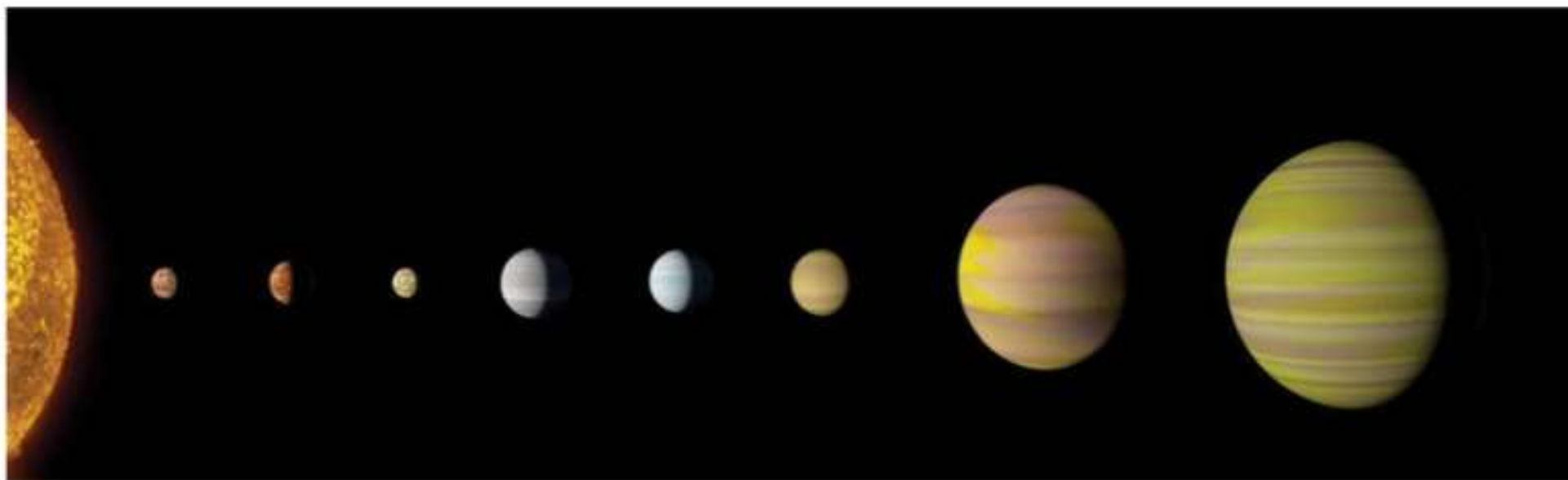
AR etc



Planet Doves

Dec. 14, 2017
RELEASE 17-098

Artificial Intelligence, NASA Data Used to Discover Eighth Planet Circling Distant Star



With the discovery of an eighth planet, the Kepler-90 system is the first to tie with our solar system in number of planets.

Credits: NASA/Wendy Stenzel

4 октября 1957 г.

