



ifj


Long delayed radio echoes – 80 years with an unexplained phenomenon

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Long Delayed Echo

- LDE =
 - echo received after a second or so
 - or everything longer than 138 ms (round-trip time around the earth)
 - An LDE which is well understood: Earth-Moon-Earth 
- First reported in Oslo, Norway 1927
 - S. Holm, [Mystiske forsinkede radiosignaler i Oslo](#), Forskning.no, March 2004
 - S. Holm, “Magnetospheric ducting as an explanation for delayed 3.5 MHz signals,” QST, March 2009.

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Shortwave in the 20's

- 3-30 MHz or 100-10 m wavelength
- First trans-Atlantic signals <200 m received 11 Dec 1921
- 1924: 80, 40, 20, 5 meter amateur bands
- First short wave broadcast, 11 March 1927, PCJJ (Philips) from NL to Indonesia

LDE:

INGENIØR
Jørgen Hals
TELEGRAMADRESSE: ELEKTROINDUSTRI
TELEFONER: 3551-1855

CHRISTIANIA

Oslo, the 29. February 1928,
Sjøfartsbygningen værelse 630.

I had expected a letter in Norwegian ...

Professor Carl Størmer Esq.,
B y g d ö y .

I herewith have the honour to advise you that in the end of the summer 1927 I repeatedly heard signals from the Dutch short-wave-transmitter P.C.J.J., Eindhoven. At the same time as I heard the telegraph-signals I also heard echo. I heard the usual echo, which goes round the earth with an interval of ca. $1/7$ second as well as the weaker echo ca. 3 seconds after the head-signal had gone. When the head-signal was especially strong, I supposed that the amplitude for the last echo 3 seconds after lay between $1/10$ and $1/20$ of the head-signal in strength. From where this echo comes I cannot say for the present, but I will only herewith confirm, that I really heard this ~~signal~~ *echo*

C. Størmer, "Short wave echoes and the aurora borealis,"
Nature, No. 3079, Vol. 122, p. 681, Nov. 3, 1928.

Yours truly

Jørgen Hals

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Huk aveny 7b, Bygdøy, 1927

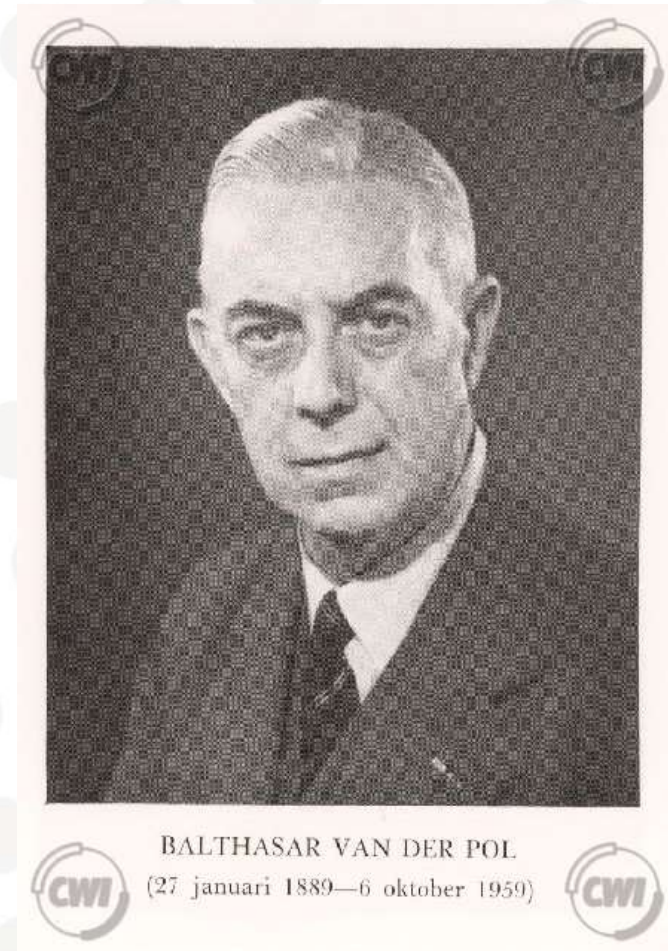


Oslo kommune, byarkivet, fotodatabasen

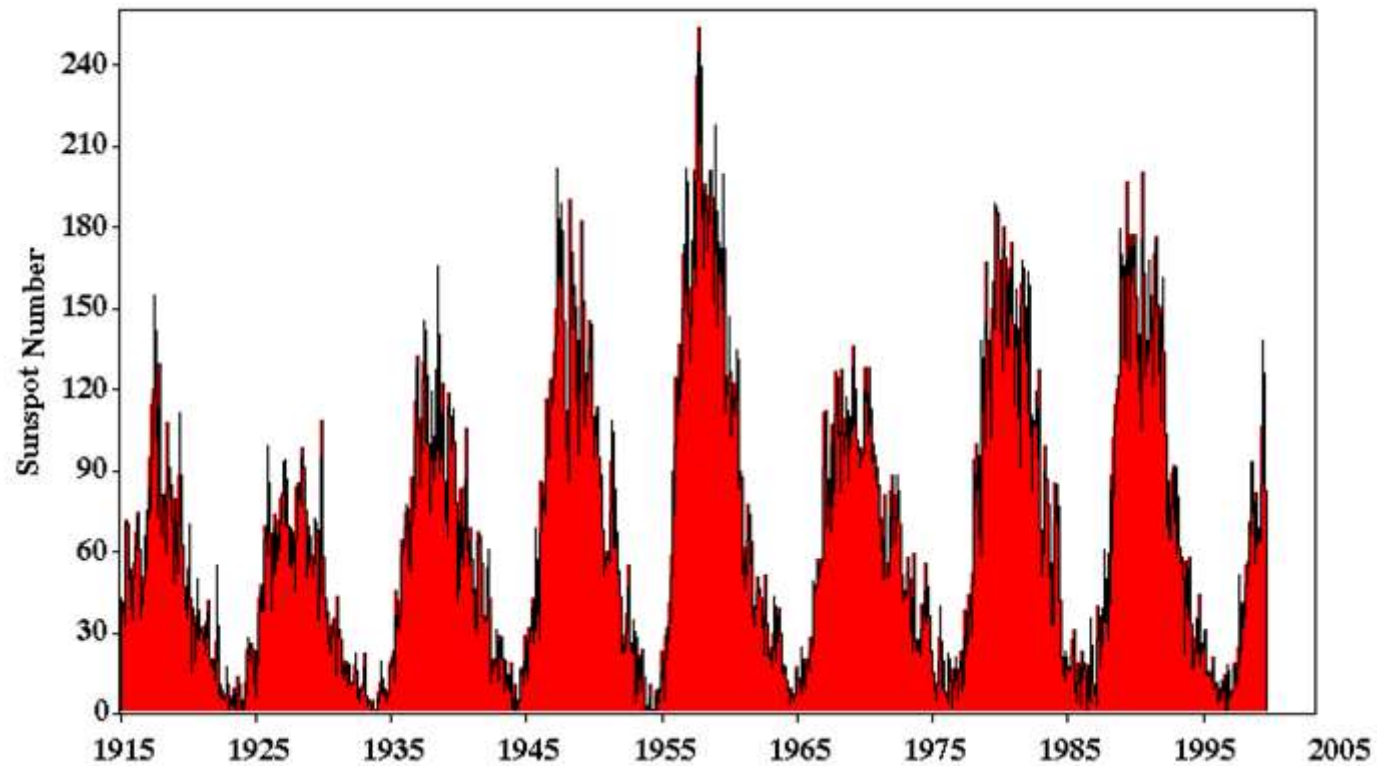
- <http://www.byarkivet.oslo.kommune.no/>
- A-20027/Uh/0001/294
- Bilde fra 1950

LDE: 1928 - 1930

- Regular 30 kW test transmissions from the Netherlands and at times from Indonesia (15.94 m).
 - B. van der Pol, early 1928- Jan 1930
 - Largest effort ever undertaken for LDE study?
 - Hals and Størmer both heard echoes in the fall of 1928



Summer 1928: peak of solar cycle



NOAA

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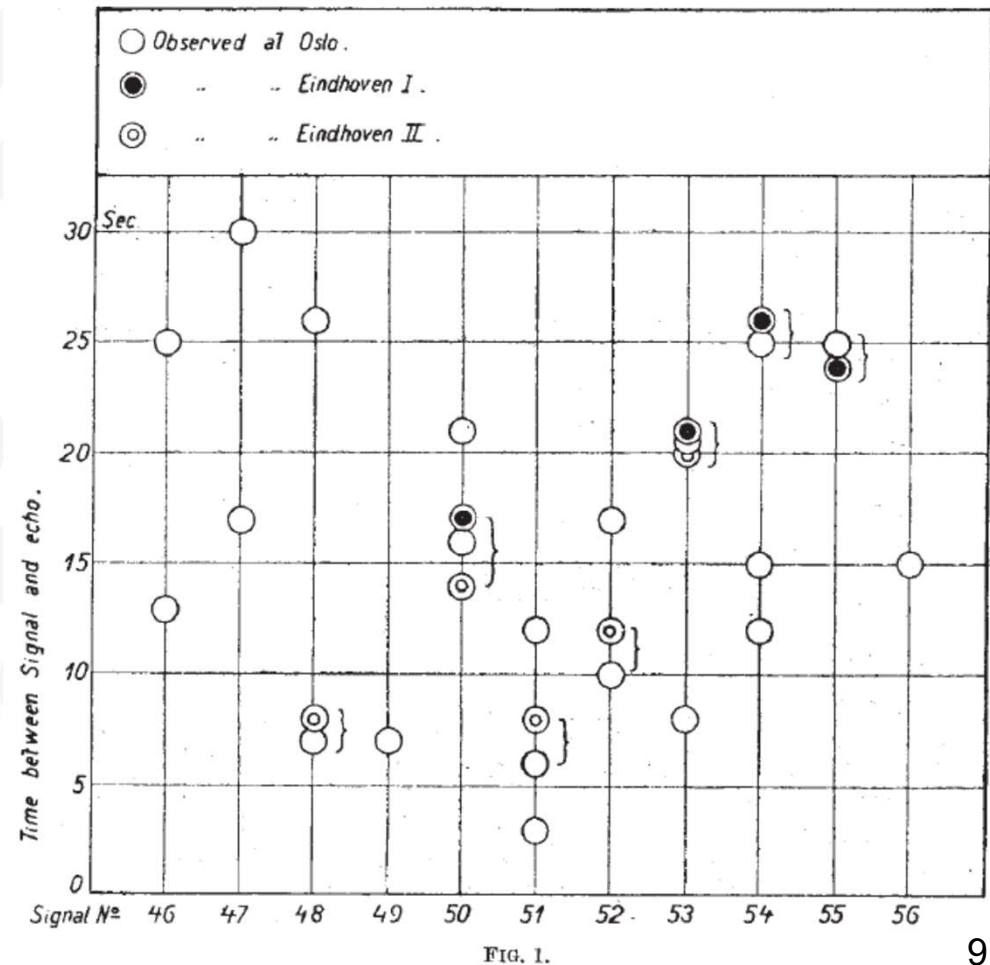
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Logical extension of range of radio...

- 4 Dec 1928, Newspaper, Dagens Nyheder og Nation....”
 - Echoes of 3-17 sec (expects several minutes) – logical progression in range of radio waves:
 - Local
 - Across the Atlantic
 - Around the earth 1 and 2-3 times
- P O Pedersen (1874-1941), Danish engineer and physicist, collaborated with Valdemar Poulsen

Convincing: Simultaneous observation of echoes, NO and NL

- Echoes from PCJJ, Hilversum, $\lambda=31.44$ m, 9.54 MHz
- Heard in Oslo and Eindhoven, 24 Oct 1928, 16-17 UTC
- Convinced most sceptics at the time that the effect was real
- B. v. d. Pol, "[Short wave echoes and the aurora borealis](#)," Nature, No. 3084, Vol. 122, pp. 878-879, Dec. 8, 1928.
- Measurement campaign:
Inconclusive on why



Carl Størmer

Fredrik Carl Mülertz Størmer (September 3, 1874 – August 13, 1957) was a Norwegian mathematician and physicist, known both for his work in number theory and for studying the movement of charged particles in the magnetosphere and the formation of aurorae

He then studied with Picard, Poincaré, Painlevé, Jordan, Darboux, and Goursat at the Sorbonne in Paris from 1898 to 1900.

He visited Göttingen in 1902, and returned to Oslo in 1903, where he was appointed as a professor of mathematics, a position he held for 43 years.

Størmer was a foreign member of the Royal Society and a corresponding member of the **French Academy of Sciences**. He was given honorary degrees by Oxford University (in 1947), the University of Copenhagen, and **the Sorbonne**, and in 1922 the **French Academy awarded him their Janssen Medal**. In 1971, the crater Störmer on the far side of the Moon was named after him



http://en.wikipedia.org/wiki/Carl_Størmer

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NOVEMBER 23, 1934

WORLD-RADIO

731

THE DISCOVERY OF ECHOES OF LONG DELAY

By JØRGEN HALS

Introduction

It is a great pleasure to be able to introduce to the readers of WORLD-RADIO and members of the World Radio Research League the original notes of Mr. Jørgen Hals, the discoverer of echoes of long delay. These notes are published in this country for the first time.

Mr. Jørgen Hals is a Norwegian civil engineer and a keen student of radio. His discovery gave him an international reputation. His work is universally recognised, and his results are always quoted whenever wireless echoes are mentioned.

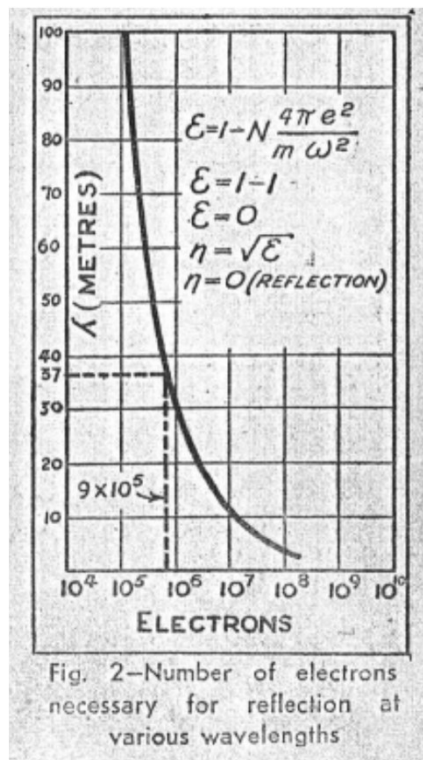
It is necessary to state that at the time when these notes were written nothing was known definitely about the Appleton Layer. The first announcement of its existence was made on September 3, 1927, in an article in Nature entitled: "The existence of more than one ionised layer in the atmosphere." I have this on Professor Appleton's authority.

RALPH STRANGER.



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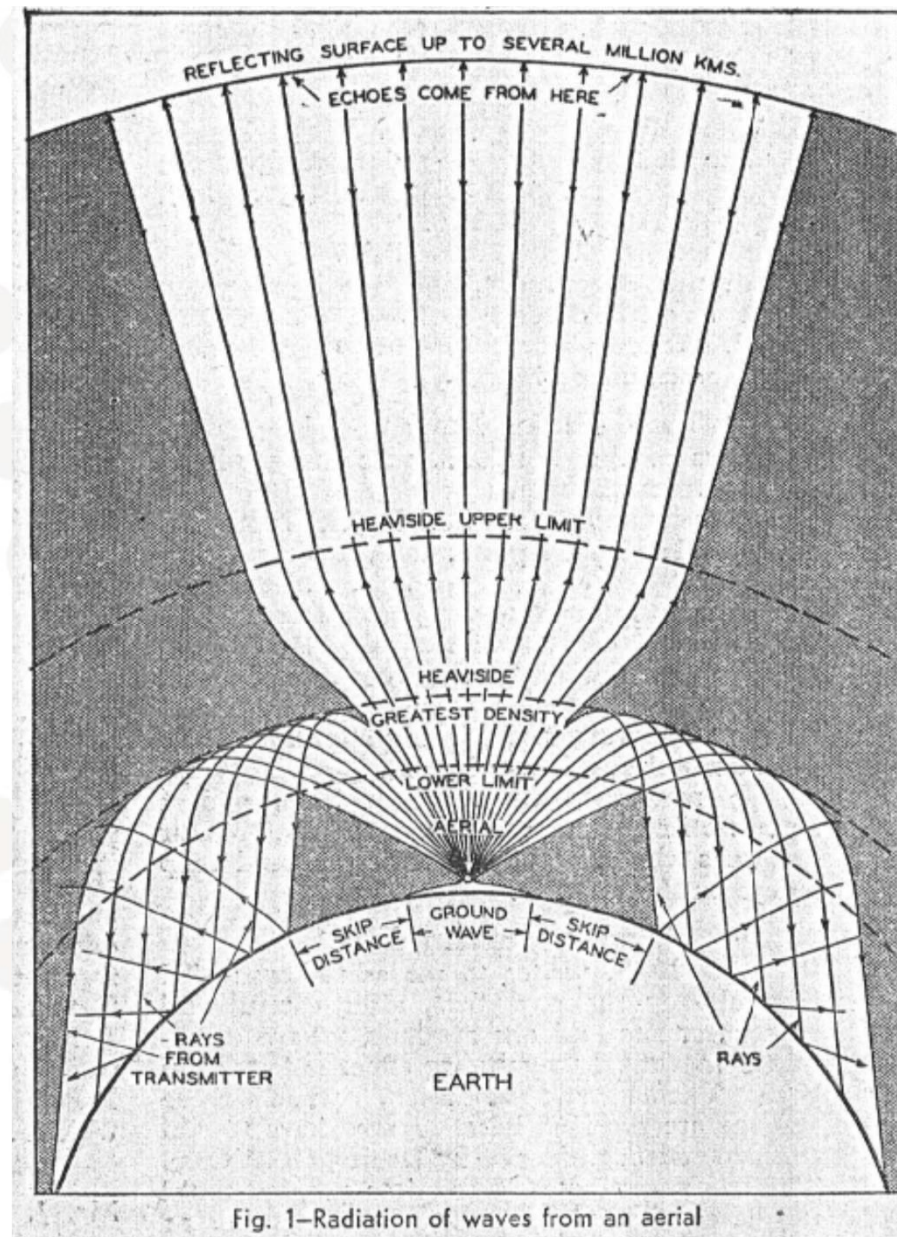
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J. Hals (1934), drawn before the discovery of the Appleton layer

- Heaviside-Kennely = E-layer (90–150 km)
- Appleton layer = F-layer (150–800 km)

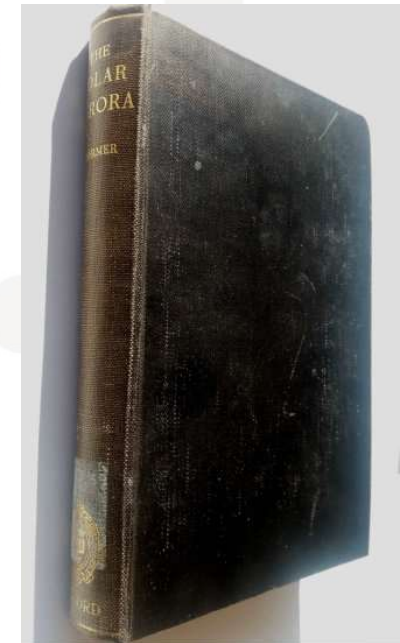
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Størmer's hypothesis

- Reflection from a toroidal surface formed by streams of charged particles from the sun.
 - Distance several ten's times the earth's radius
 - Predicts seasonal behavior with best reflection during spring and fall equinoxes.
 - Størmer's original hypothesis from 1928 which he also elaborated on in his book from 1955
- Later confirmed: [the Van Allen radiation belt](#), but the distance is only 4-5 earth radii, i.e. 0.2 seconds round-trip time.



Obituary 10 Feb 1942

- Deceased, almost 52 years old
- Engineer, contractor: buildings, power plants, factories
- 1926 (sic): Much remarked in scientific circles when he discovered the much publicized radio echo from space
- 1935: Pointed out the moon's influence on the Heaviside layer (?)
 - Appleton: He found that the height of the ionospheric layers was affected by the Moon as well as the Sun, ...
http://www.radio-electronics.com/info/radio_history/gtnames/edward-victor-appleton.php
- 1937: ... participated in the int. short wave conference (physics section) in Vienna
- Morgenbladet 10 Feb 1942

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Ingeniør Jørgen Hals, Bygdøy, er død, nær 52 år gammel. Han var opvokset i Aker og Oslo, og har utført en lang rekke arbeider på de forskjellige områder. Således utførte han anlegg i elektrisitetsverk, valseverk, verksteder m. l. og hadde tekniske konsulentarbeider i bygningsbranchen, i maskin og varme og i den elektriske branche. Sine siste arbeider utførte han i Fridtjof Nansens pl. 8. Denne bygning er blitt den mest moderne i Oslo, samtidig som den representerer den dypeste fundamentering som hittil er utført her hjemme og vistnok også i hele Europa. Ingeniør Hals vakte i 1926 stor opsikt i videnskapelige kretser da han opdaget det meget omtalte radioekko fra verdensrommet. I 1935 påviste han månens innflydelse på Heaviside-laget. Hals var den eneste nordmann som deltok i den internasjonale kortbølgekongress (fysikk-avdelingen) i Wien 1937, hvor videnskapsmenn fra alle kanter av verden var representert.



10-2-42

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5 mechanisms – only 1 is understood

1. Ducting in the magnetosphere and ionospheric reflection
2. Travel many times around the world
3. Mode conversion w/ coupling to mechanical waves in ionosphere
4. Reflection from distant plasma clouds
5. Non-linearity in addition to mode conversion

•R. J. Vidmar and F. W. Crawford, "[Long-delayed radio echoes: Mechanisms and observations](#)," Journ. Geophys. Res., 1985.

Magnetospheric ducting

7. Nov 2015: 3.5 MHz, several
heard it, California

3. Feb 2016, 3.5 MHz, 2
Suffolk and Devon, UK

Magnetic field line, geomagnetic latitude: 42.5 deg, L: 1.8397, delay: 126 ms

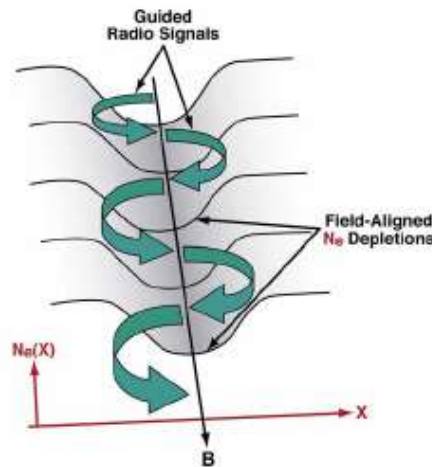
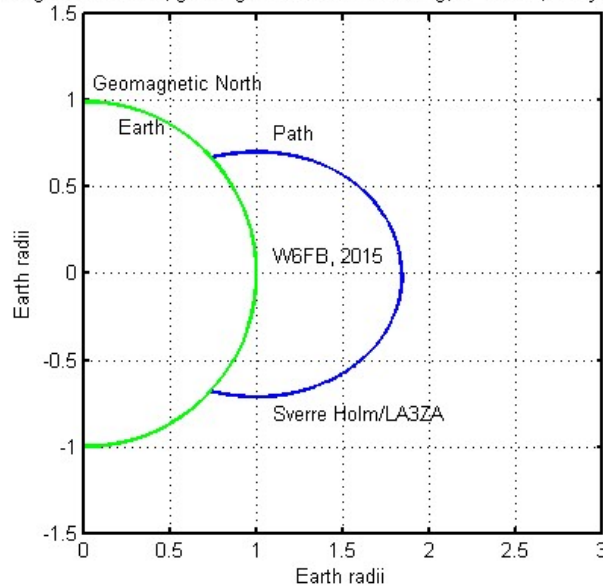
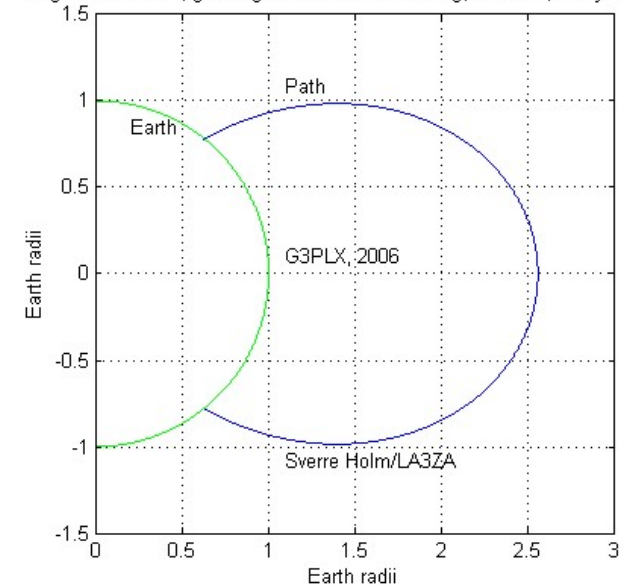


Figure 2. A schematic of ducting of a high-frequency ($f \gg f_{ce}$) electromagnetic wave (green arrows) by field-aligned electron density depletions.

Magnetic field line, geomagnetic latitude: 51.3 deg, L: 2.558, delay: 211 ms

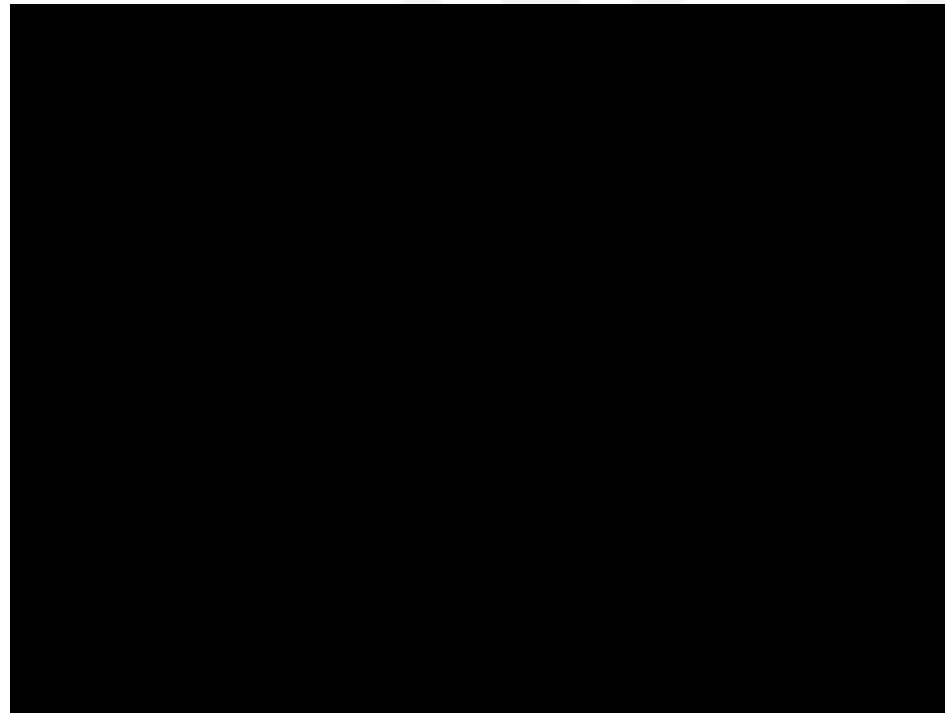


<http://la3za.blogspot.no/search/label/MDE>

•Fung, Green, Modeling of field-aligned guided echoes in the
plasmasphere, Journ. Geophys. Research. D. Atmospheres, 2005

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3. Feb 2016, 3.6 MHz, Suffolk
5W, 1W and 100mW



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- *J. Hals: "From where this echo comes I cannot say for the present, but I will only herewith confirm, that I really heard this echo"*
- *World-Radio, 1934: His work is universally recognised, and his results are always quoted whenever wireless echoes are mentioned*
- *C. Størmer, "Short wave echoes and the aurora borealis," Nature, Nov. 1928.*

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Read more

- Wikipedia: Long Delayed Echo, refers to my two pages below
 - https://en.wikipedia.org/wiki/Long_delayed_echo
- The Five Most Likely Explanations for Long Delayed Echoes:
 - <http://heim.ifi.uio.no/~sverre/LDE/>
- 15 Possible Explanations for Long Delayed Echoes
 - <http://heim.ifi.uio.no/~sverre/LDE/Shlionskiy15.htm>

Thanks:

- Nasjonalbiblioteket:
 - Anne Melgård, Nina Korbu
- Universitetsbiblioteket, Oslo:
 - Knut Hegna
- Radio amateurs who have contacted me over the years with examples of echoes due to ducting in the magnetosphere