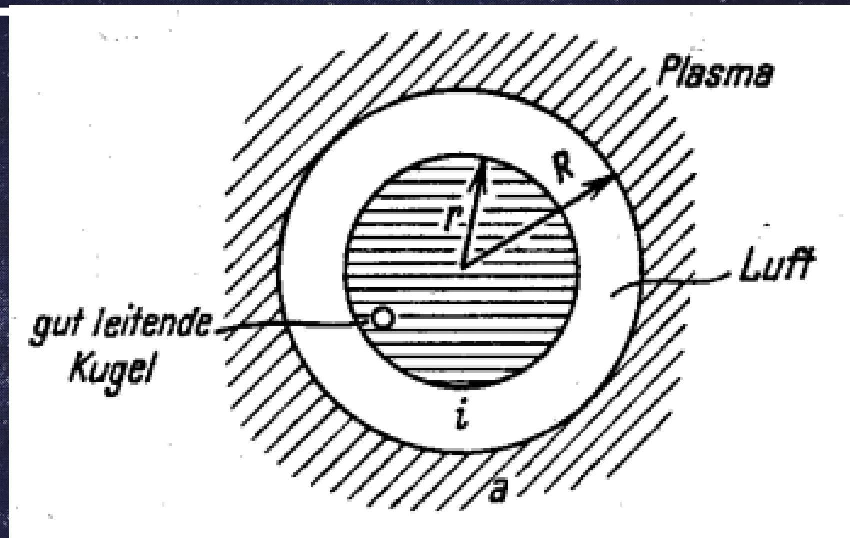
# SCHUMANN RESONANCE BARRIERS TO DETECTION

Norman Pomfret M0SXF

# WINFRIED OTT0 SCHUMANN

1888 -1974




Ea Circumf. ~38 Mm

SR Frequency $\sim \frac{c}{\Lambda}$

$\sim \frac{300Mm/S}{38Mm}$

$\sim$ 7.8 Hz

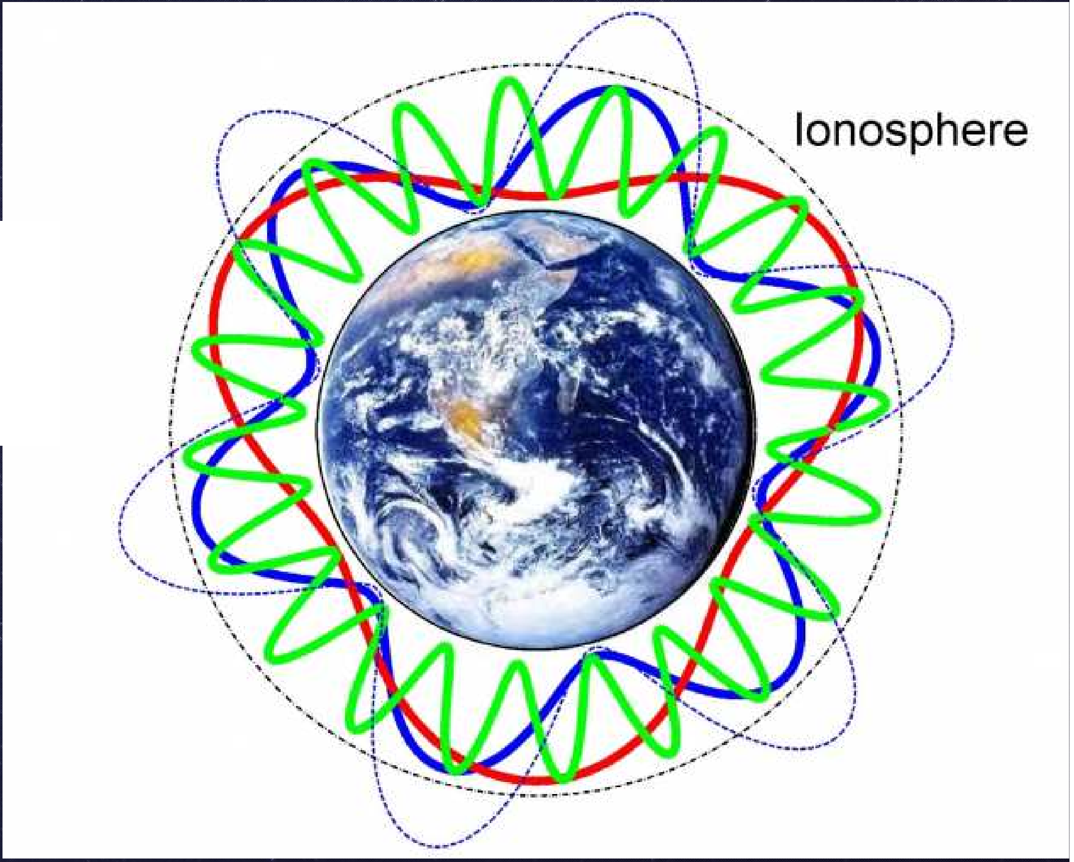
Images Internet

# SCHUMANN RESONANCES 1

The Cavity has a volume of Spherical dimensions.

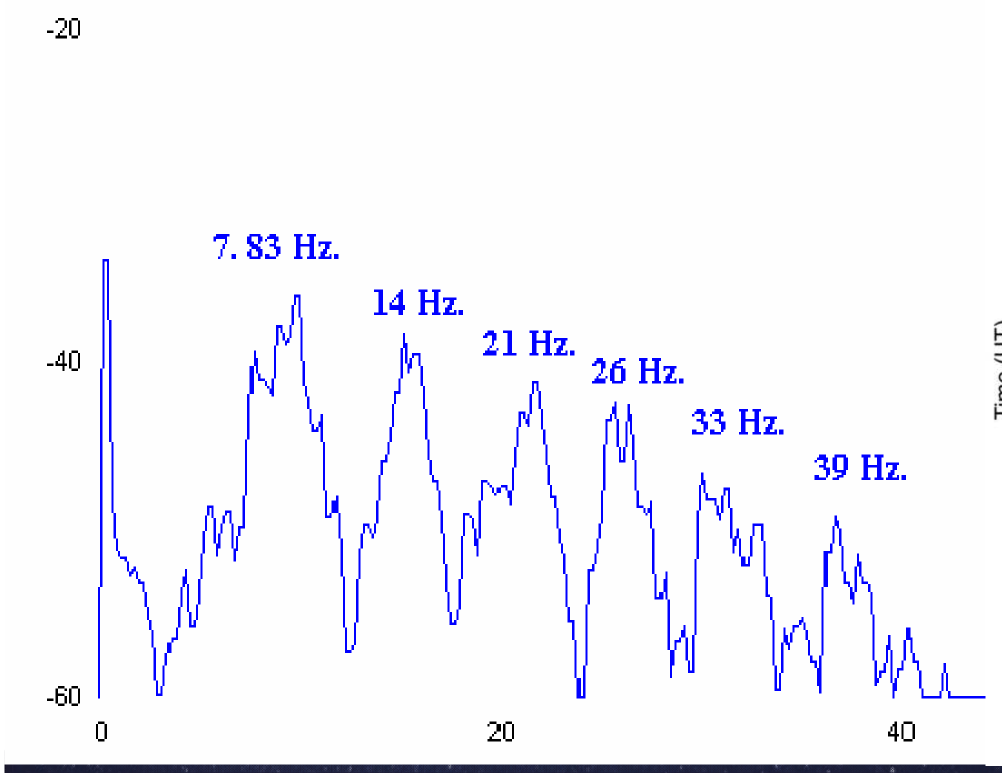
$$f_n = \frac{c}{2\pi a}\sqrt{n(n+1)}$$

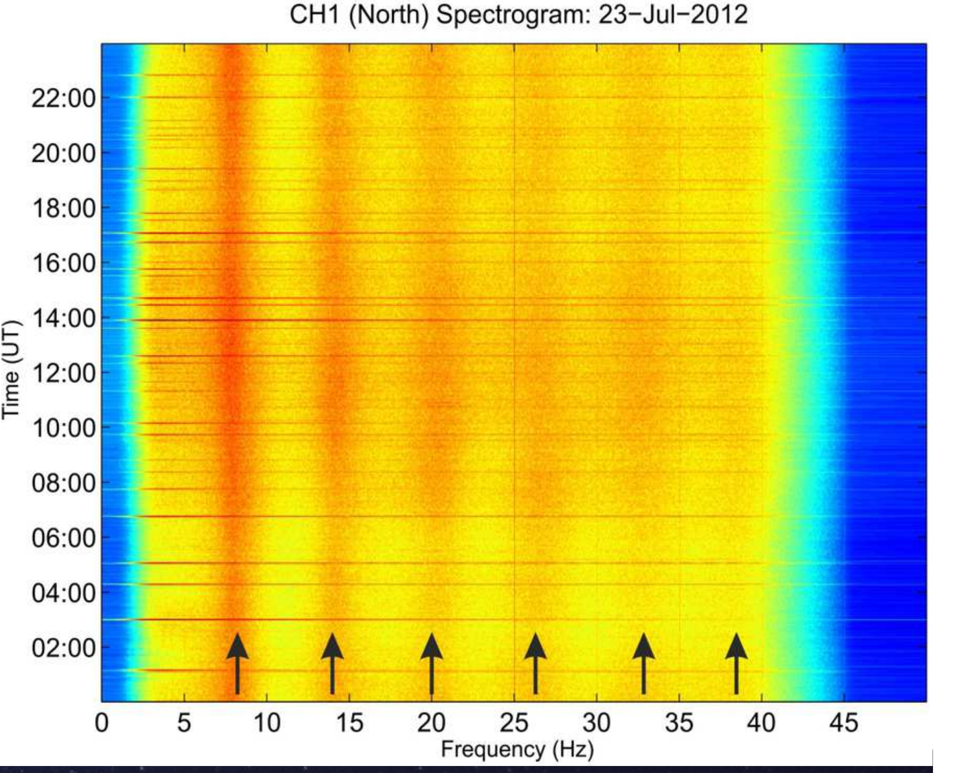
These resonances appear at Approximately : 7.8 14.5 20.8 27.3 33.8 39.0 Hz and higher




Note these are Standing Waves, are continuous and an integral number of cycles (not Hertz). Three waves are shown Red Blue & Green.
Icon Image Courtesy NASA

# SCHUMANN RESONANCES 2



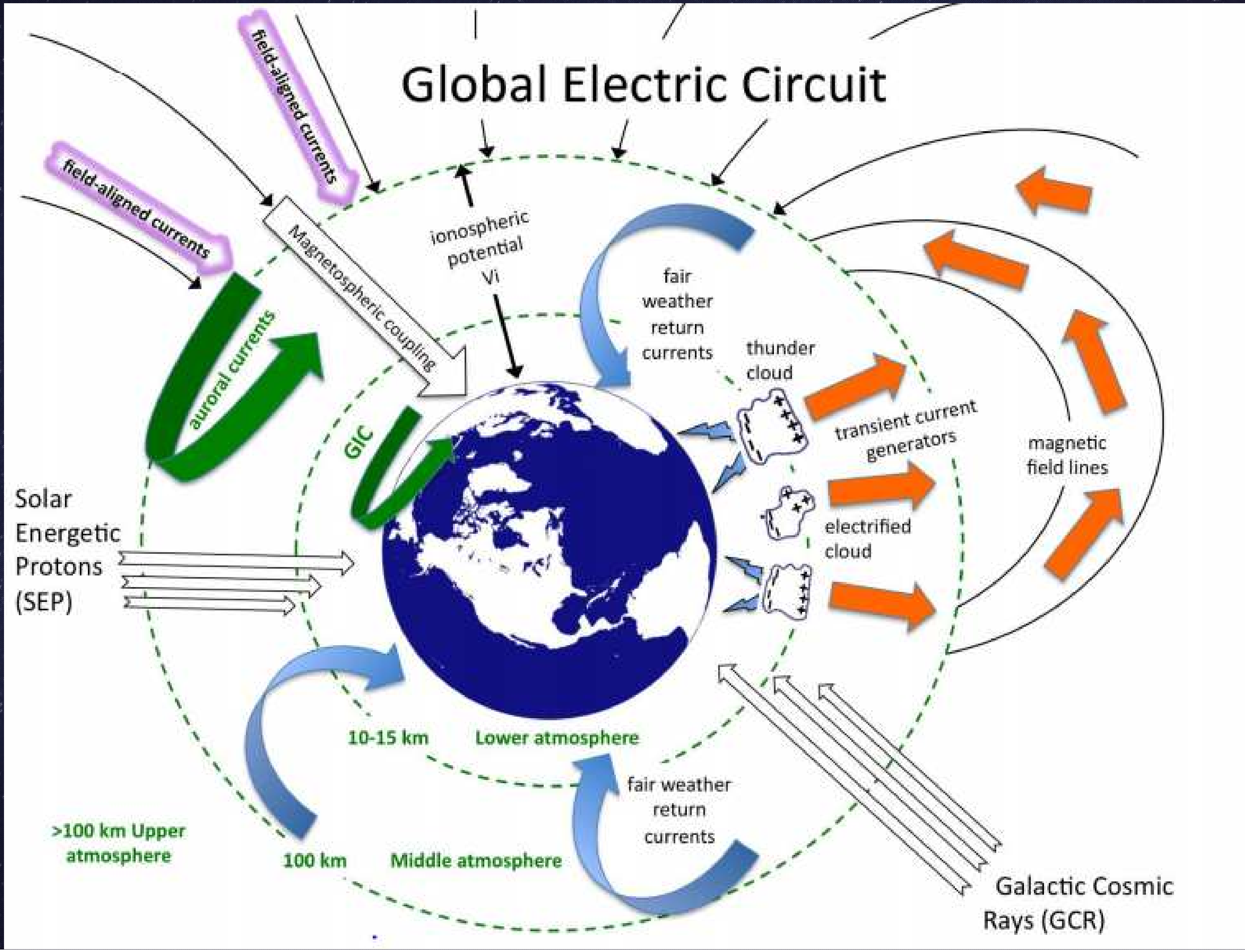

A typical Schumann Resonance Signal, at a particular moment.
Amplitude in relative arbitrary units.

Image Internet

A typical SR Signal, as a 'Waterfall Plot' spanning 24 hours, amplitude arbitrary units. The horizontal lines are 'Noise' or interference.

Image British Geological Survey.

# IONOSPHERE

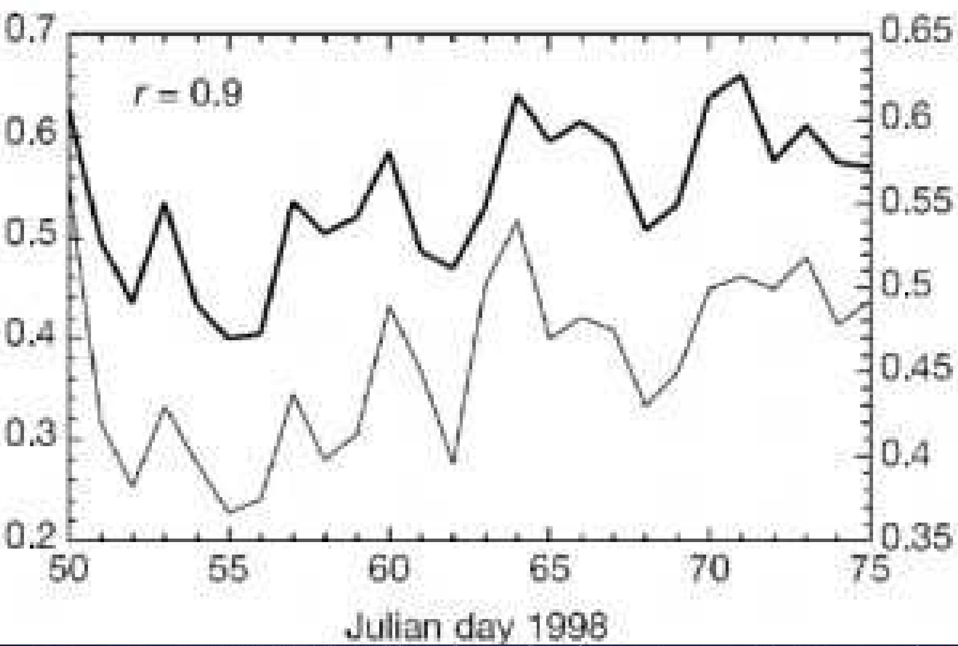


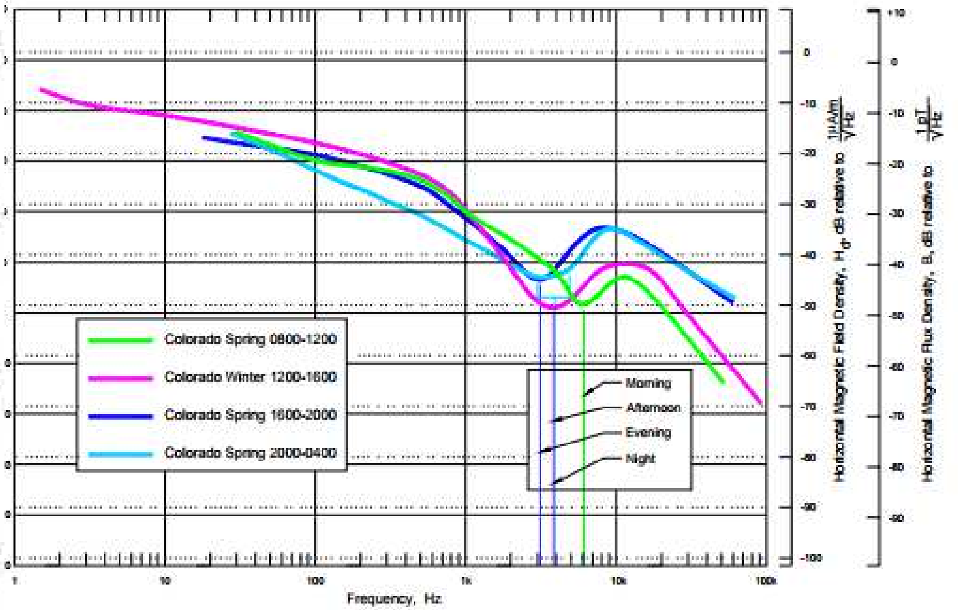
Global Electric Circuit
field-aligned currents
field-aligned currents
Magnetospheric coupling
ionospheric potential Vi
auroral currents
GIC
fair weather return currents
thunder cloud
transient current generators
electrified cloud
magnetic field lines
Solar Energetic Protons (SEP)
10-15 km
Lower atmosphere
fair weather return currents
>100 km Upper atmosphere
100 km
Middle atmosphere
Galactic Cosmic Rays (GCR)

# BARRIERS TO DETECTION

- Schumann Signal & Noise floor
- Induced Coil Voltage
- HUM
- Permeability Relative & Geometry (effective )
- Parasitic Capacitance
- Noise - Johnson Noise & 1 / f - Noise
- Environmental Weather & Lightning
- Environmental Wildlife

# THE RESONANCE SIGNAL




gure 4 Best-fit noise density curves for morning, evening, and night hours

Schumann Resonance
On a particular day
Signal typically 0.5 pT
Image

ELF Noise Floor
Noise level typically
0.1 pT at 10 Hz
Image Peter Malloy

# INDUCED COIL VOLTAGE

**Question** Why should this be a barrier ?

Vind = µ0 . N . a . F . H . µr for For 1 turn, area of 1 sqm

. = 4π10e-8 . 1 . 1 . 2π10 H . µr

~ 800 . 10e-8 H . µr

~ 1 . 10 e-15 or 1fV per turn per sq m of coil area

For 100,000 turns and an area of 2,500 sq mm

= 1 . 10 e-15 . 10 e5 . 2,500 10 e-6

~ 0.25 10e-12 or = 0.25 pV ( in the order of )

**Answer** **The induced signal is so very small**

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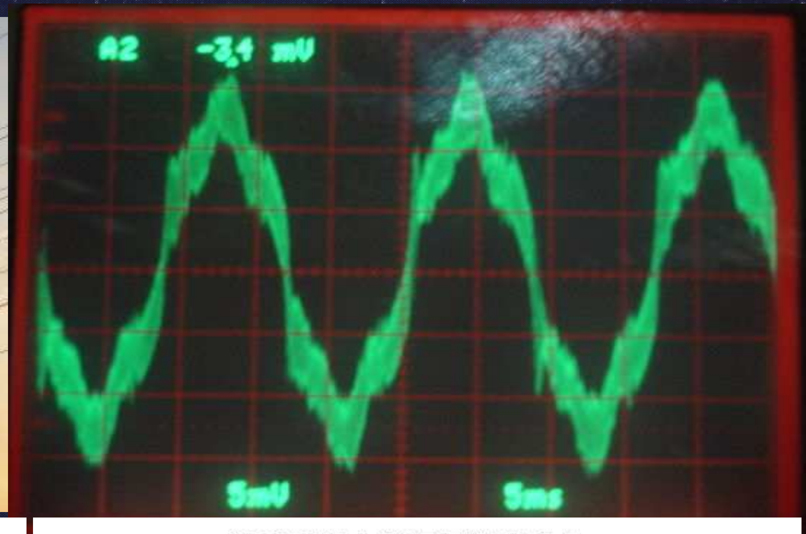
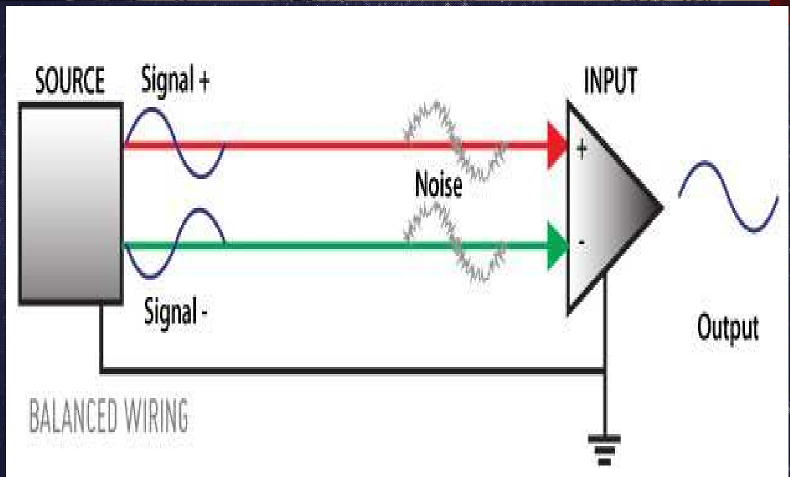
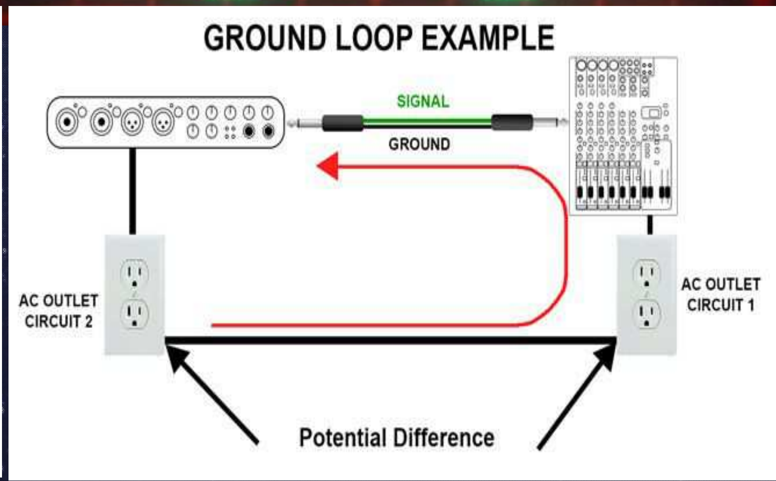
# HUM !*#



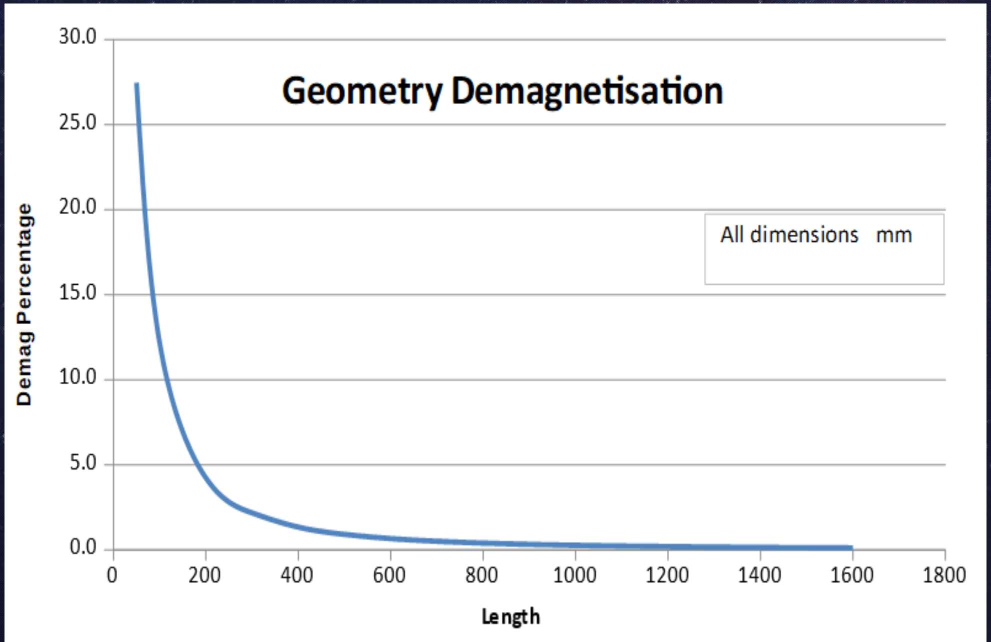




Its ALL PERVADING and it is almost EVERYWHERE

# PERMEABILITY

Permeability of Ferro-Magnetic material is determined by the Manufacturer, a Cost : Benefit choice, for use at the Frequency of Interest and Ambient Temperature range.

Permeability Loss due to Anisotropy, a Design choice. Loss / Space




Sample Blocks each L= 100 W = 25 H = 25

It is the effective ratio of Length / effective diameter

$$\mu_{eff} = \mu_r / (1 + N)(\mu_r - 1)$$

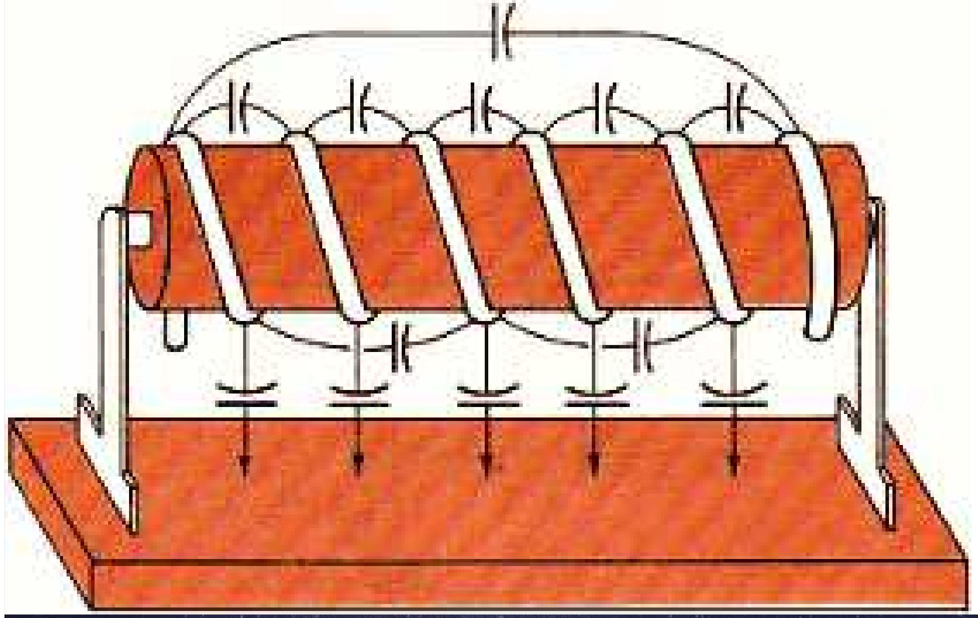
For high values of $\mu_r$

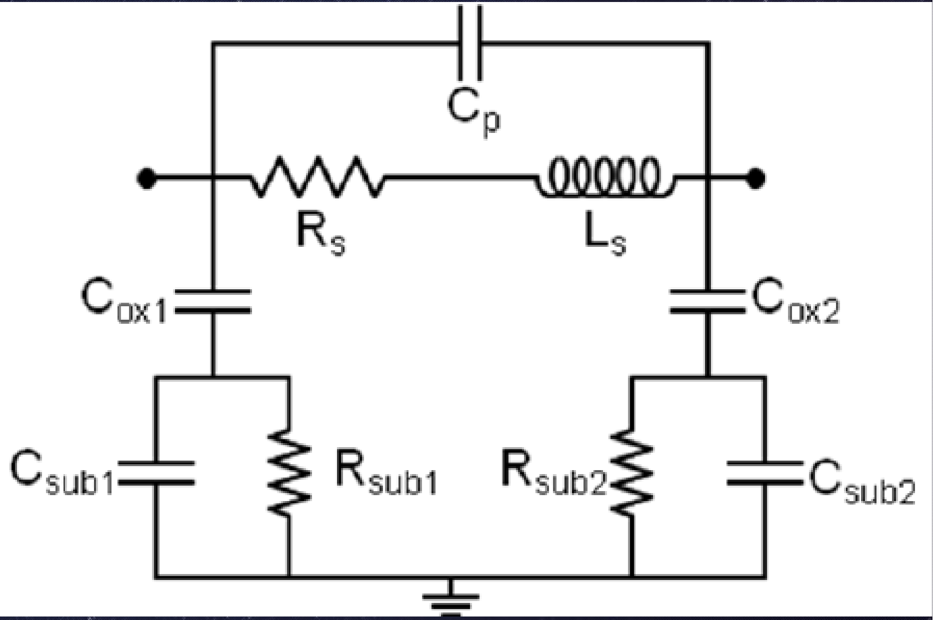
$$\mu_{eff} = 1 / N$$

$$N = \frac{1}{m.m\,(\ln(2m) - 1)}$$

Length : diameter ratio of 25 :1 Offers low demagnisation or anisotropy loss, less than 1%

# PARASITIC CAPACITANCE

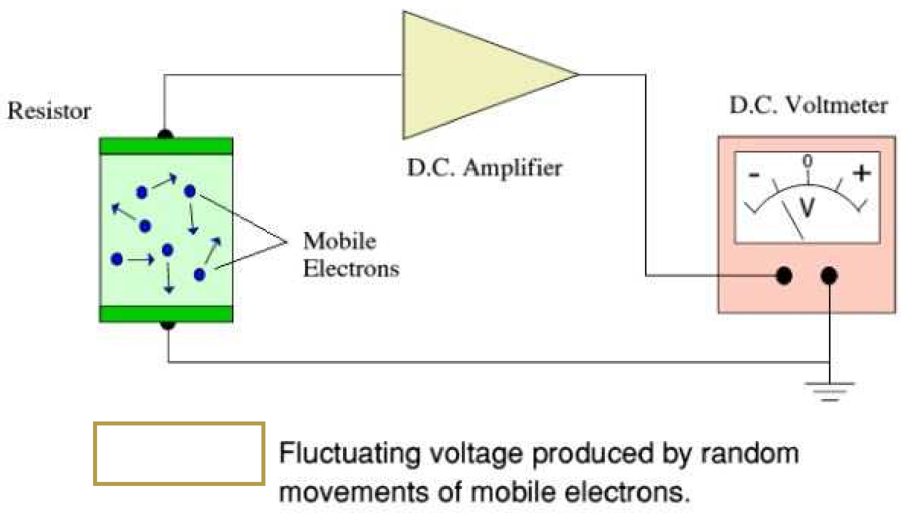





Only small Capacitances between every: Turn; Layer, and Everywhere else, especially to Earth or Ground, they are distributed.

This capacitance is inherent to its construction, it will create a tuned circuit at a particular frequency. Ensure this is Out of Band

# NOISE, JOHNSON




$$\overline{v_n^2} = 4k_B T R$$

Kb = Boltzmann's Const.
T Temperature in deg K
R Resistance in Ohms

Discovered by John Johnson in 1926 and explained by Harry Nyquist, both working for Bell Telephones.

It is a Thermal Noise with an even power spectral density

Caused by random movement of mobile electrons

# EUCARA NOISE, I/F ( KNOWN AS IF)

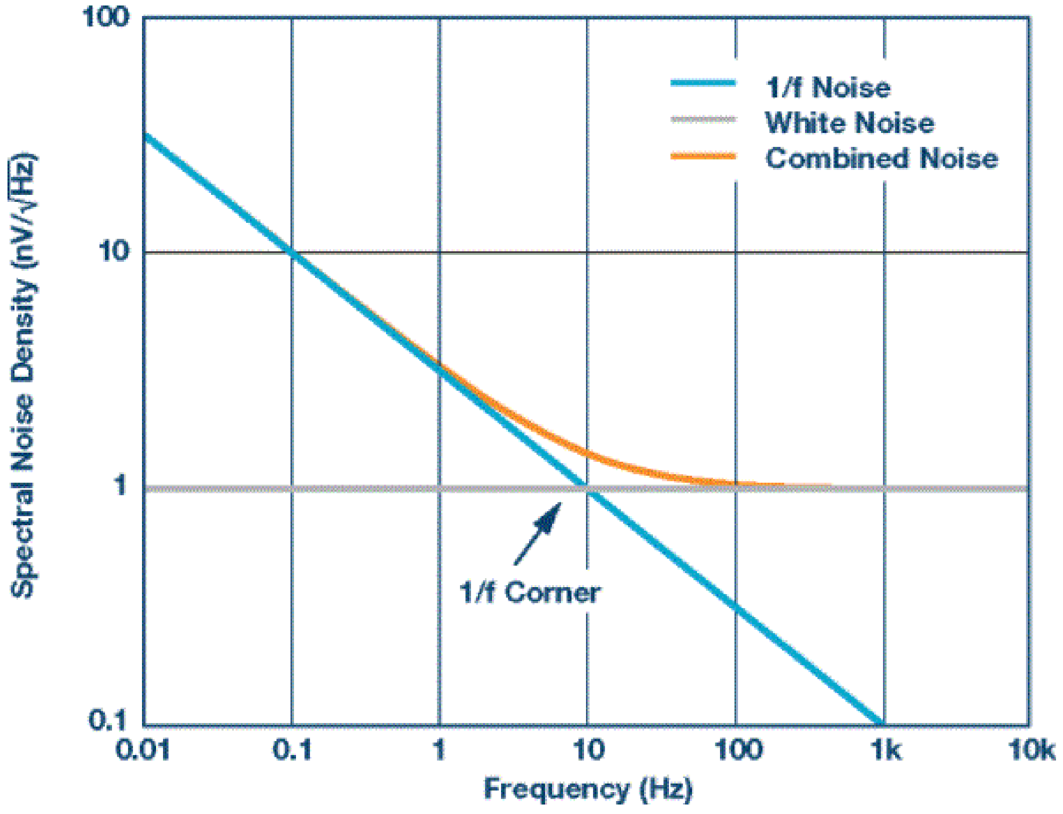


*Figure 1. Typical noise spectral density plot for a low noise electronic component.*

$$Noise\_Power\left(f\right)=\left(\frac{k}{f^{\alpha}}\right)$$

Where :

k is a magnitude coefficient

α is an exponent greater than 1

A very pervasive form of noise, that becomes very apparent at Low Frequencies

Spectral noise density is inversely proportional to frequency, hence 1/f
It rises at the rate of 10 dB per decade of frequency range

# ENVIRONMENTAL - WEATHER

# ENVIRONMENTAL - ANIMAL

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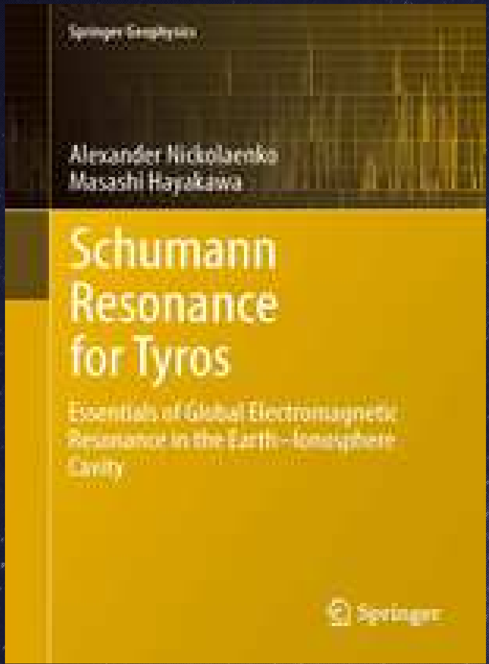
# REFERENCES




A list of Books that may be useful are listed in the Presentation Notes.

This book has been especially useful for understanding more of the phenomena.

Schumann Resonance for *Tyros*

There are many papers published on the Internet relating to the Resonance and most of the factors discussed in this presentation. A small number of papers relating to, Schumann Resonance Sensors are listed in my Notes.

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# WHAT NEXT

1. Build the Sensor **:** Induction Coil, LNA,

2. Detect the Schumann Resonance

3. Write the Project Documentation (to date)

4. Develop the DSP Techniques to extract Information from the Data

5. Develop Tools for : Evaluation, Testing and Calibration for ELF e.g Noise Source, Signal Generator, Power Signal, Large Helmholtz Coils

6. Understand how the SR Signal Changes for :
   Di-urnal Variations, Gamma Ray Bursts, Q Bursts,
   Solar Proton Events, Super Novae Event ?, And …. PPT !

# DANKE & THANK YOU

To you all, for listening to my presentation

Danke

And Thank you