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Detection of field line resonance frequencies using ground magnetometers

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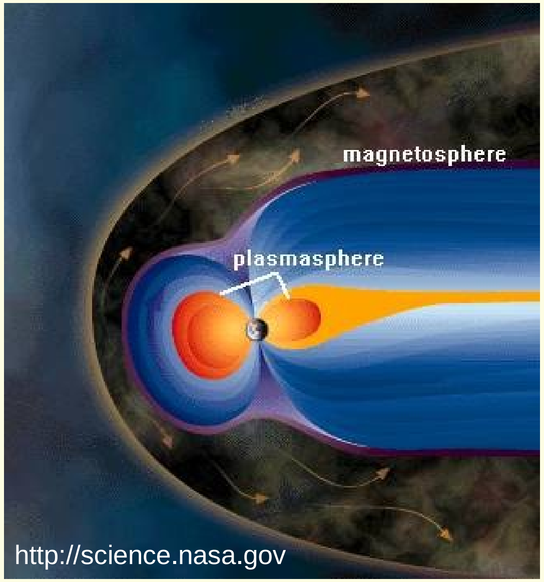
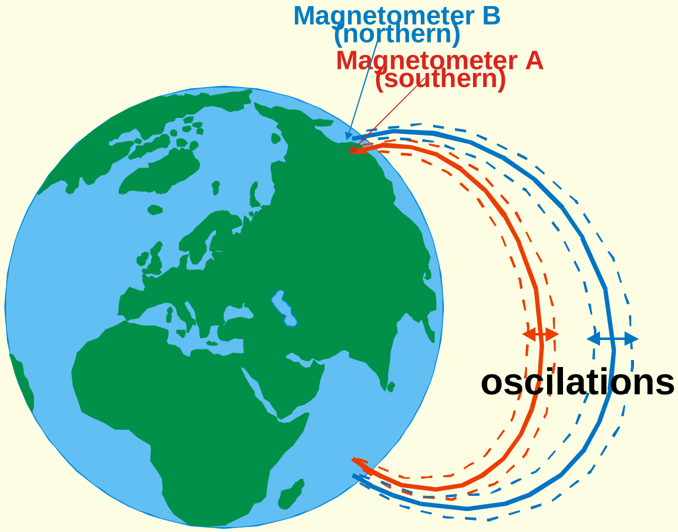
Plasmosphere and Field Line Resonance phenomenom (FLR)





Plasmosphere

- is inner magnetosphere above ionosphere,
- located above ionosphere
- consisting of low energy (cold) plasma

Field line resonance (FLR)

- phenomenon of transverse standing magnetohydrodynamic Alfven wave on magnetic field line
- this phenomenon has some similarities to the standing wave in a string of musical instrument, frequency of oscilation depends on length of field line and density

$$f_{FLR} = \frac{V_A}{2l} \qquad V_A = \frac{B}{\sqrt{\mu \cdot \rho}}$$

V_A **- Alfven velocity** l **- field line length** B **- magnetic field**

μ **- magnetic permeability** ρ **- plasma density**

Methods of detection the FLR resonant frequency

There are several methods for detection of FLR, but three are most common:

1) Dual Station, gradient method, Cross-phase method in the H-Component (figure - next slide)

   The cross-phase method examines the phase from two latitudinally separated magnetometers in order determine resonant frequency between them.

   The phase difference of the H-component between the two stations is expected to be largest when the resonance point is located at a point between the two stations.

2) Dual Station, gradient method, Amplitude-ratio method in the H component (figure - next slide)

   The amplitude-ratio method method examines the amplitude from two latitudinally separated magnetometers in order determine resonant frequency between them.

   Resonant frequency is determined on the basis of amplitude ratio A and B. Resonant frequency is located betwee two extremes, defined in the course of the ratio A / B, which is around the resonance should have two extremes.

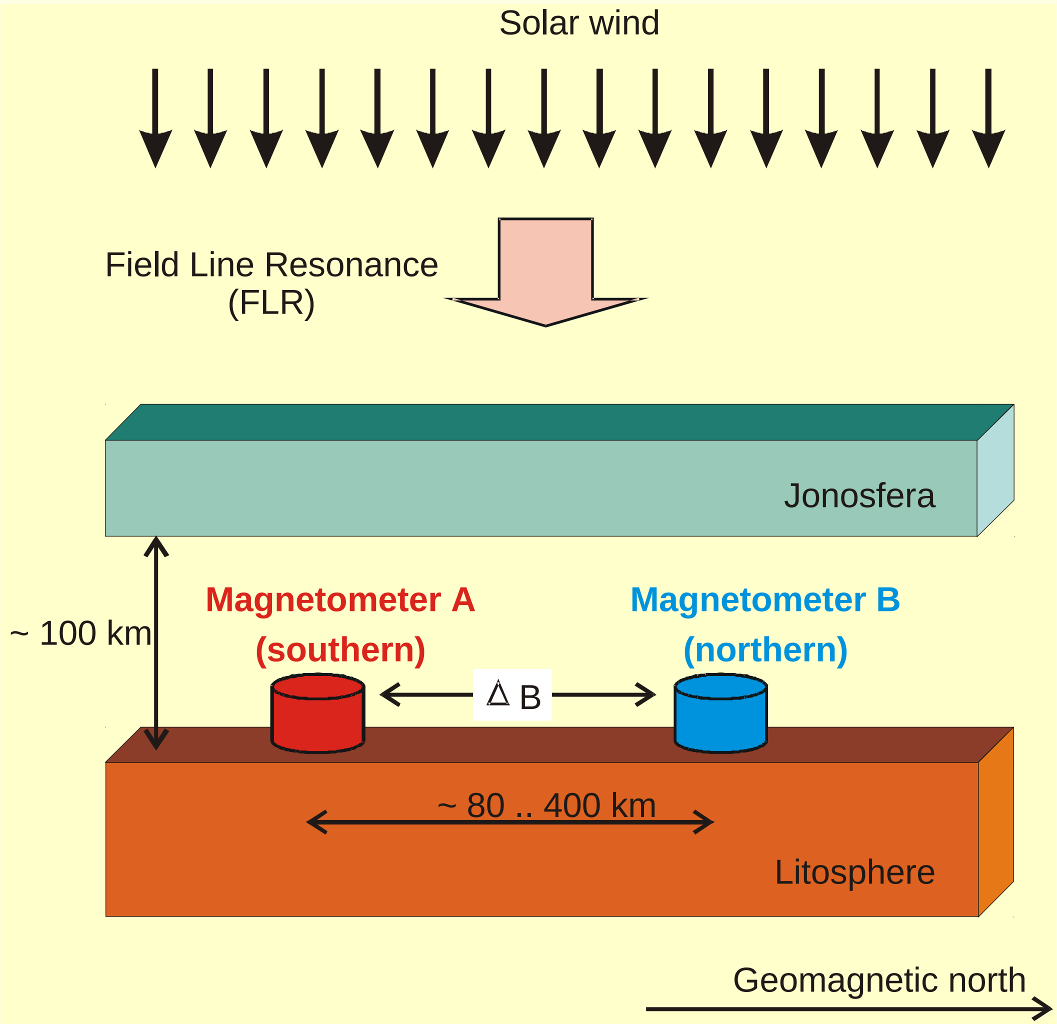
3) Single Station, H/D Ratio method

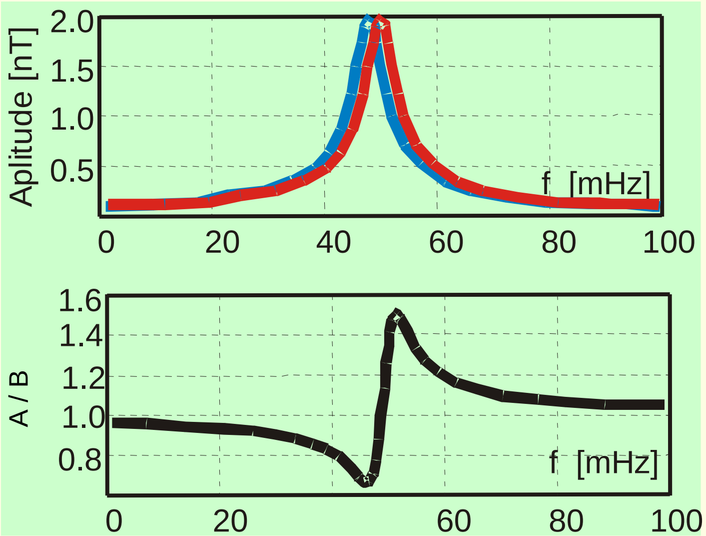
   We might expect that the D-component would respond to the cross L-shell propagating fast mode and the H-component to the toroidal mode. That's why the ratio of H to D at a single station would show a ridge in the power ratio at the toroidal resonance frequency.

   Advantages: require a single station not a pair station, not timing problems, we can find resonance at station not resonance between station

   Disadvantages: unreliable results, it is not always the case that the FLR has extra power in the H component, this method is not popular

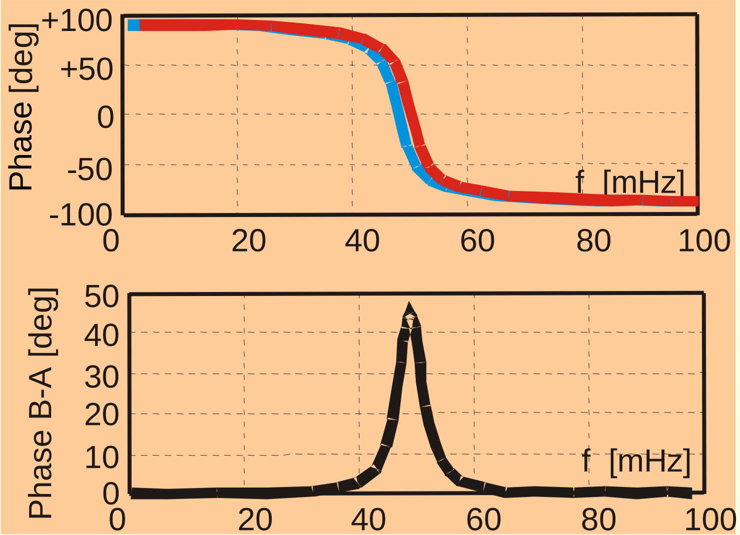
Gradient methods of detection of FLR phenomenon





„Amplitude-ratio" detection

The resonant freq. located between 2 extremes



„Cross-phase" detection

The H-component phase jumps by 180 degrees across the resonance point

References

1) „STUDIES OF GEOMAGNETIC PULSATIONS USING MAGNETOMETER DATA FROM THE CHAMP LOW-EARTH-ORBIT SATELLITE AND GROUND-BASED STATIONS” (PPT presentation), Peter R Sutcliffe, Hermanus Magnetic Observatory (HMO), South Africa, Hermann Lühr, Helmholtz Centre Potsdam – GFZ, Germany, Balazs Heilig, Tihany Geophysical Observatory, Hungary

2) Magnetoseismic Research through the Observations by Ground Magnetometer Networks (PPT presentation), Peter Chi, Institute of Geophysics and Planetary Physics, UCLA, IAGA Workshop on Magnetic Observatories, Golden, Colorado, June 16, 2008

3) Comparison of Three Techniques of Determining the Resonant Frequency of Geomagnetic Pulsations C. T. Russell , P. J. Chi , V. Angelopoulos , W. Goedecke , F. K. Chun , G. Le (1), M. B. Moldwin and E. G. Reeves , http://www-ssc.igpp.ucla.edu/personnel/russell/papers/compare_three/

4) A significant mass density increase during a large magnetic storm in October 2003 obtained by ground-based ULF observations at L $\sim$ 1.4, Satoko Takasaki, Hideaki Kawano, Yoshimasa Tanaka, Akimasa Yoshikawa, Masahiro Seto, Masahide Iizima, Yuki Obana, Natsuo Sato, and Kiyohumi Yumoto

5) http://www.richardclegg.org/htdocs/flr.html

View of the aurora from the Polish Polar Station
at Hornsund, Svalbard, Norway

Thank you
for your attention !

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