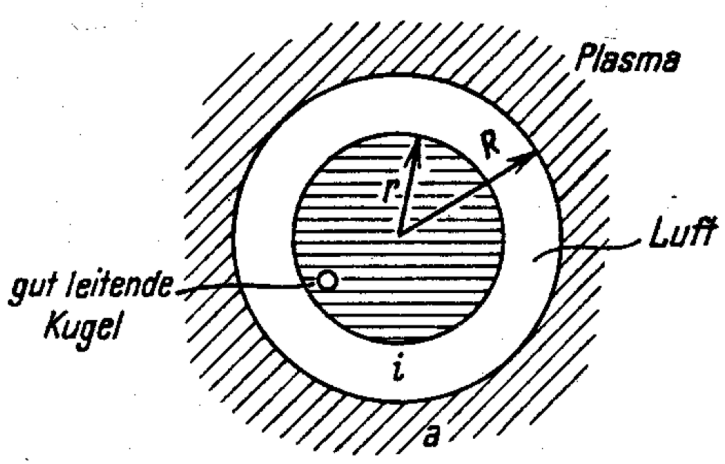
Schumann Resonances, Space Weather, Cosmic Rays

Zimborás Zoltán

Wigner Research Centre for Physics

CREDO Week, Krakow, October 5, 2018

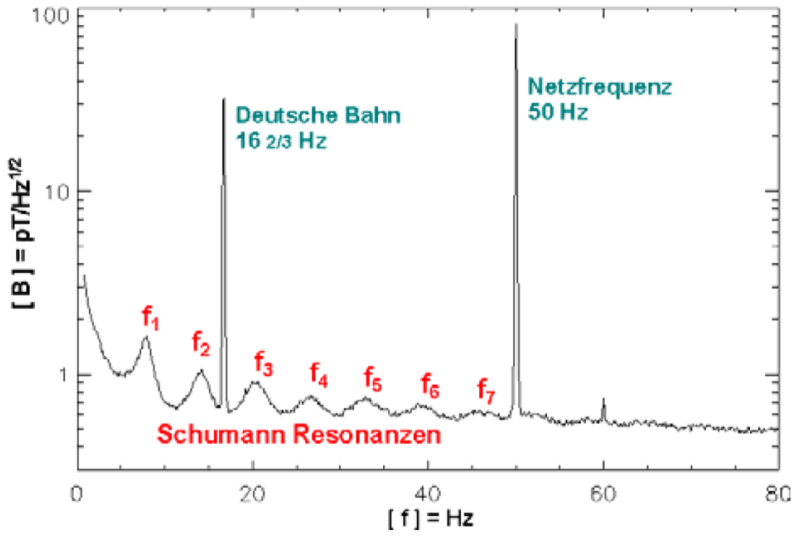
Schumann resonances



[Schumann, W.O., Über die strahlungslosen Eigenschwingungen einer leitenden Kugel, die von einer Luftschicht und einer Ionosphärenhülle umgeben ist, Z. Naturforsch. 7a, 149, (1952)]

Original sketch by Schumann for the illustration of the waveguide which is formed by the highly conducting earth and the highly conducting ionosphere, r signifies the Earth radius, and R the ionosphere radius, $R - r \approx 80km$. The obtained resonant frequencies were $f_n = 6.0\sqrt{n(n=1)}$ [Hz], which yields $f_1 = 8.46$ Hz, $f_2 = 17.70$ Hz, $f_3 = 20.78$ Hz.

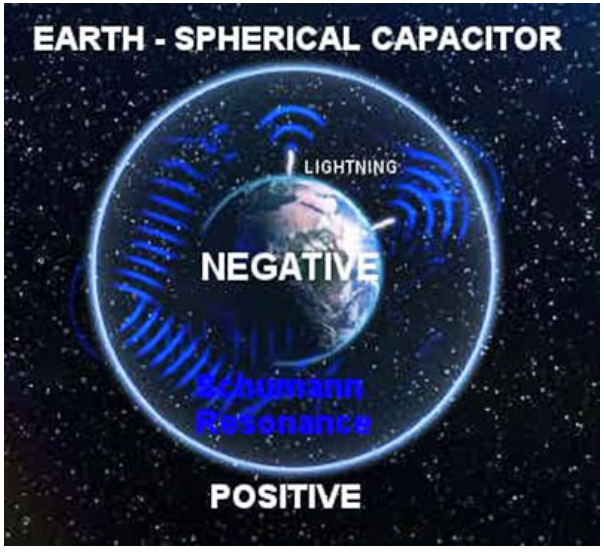
Measured Schumann Resonances

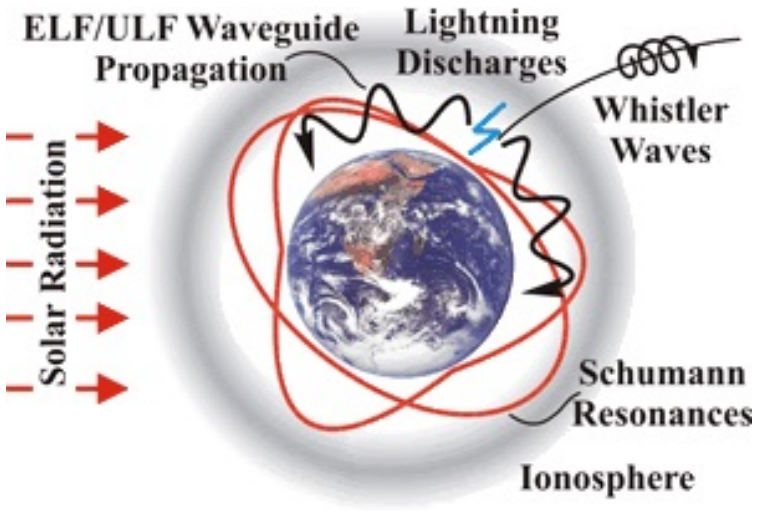


[K. Schlegel, K. Füllekrug, 50 years of Schumann resonance. Phys. Unserer Zeit 33(6):256-264 (2002)]

The experimentally observed frequencies ($f_1 = 7.8$ Hz, $f_2 = 14.3$ Hz, $f_3 = 20.8$ Hz) are close (but not equal) to Schumann's values ($f_1 = 8.46$ Hz, $f_2 = 17.70$ Hz, $f_3 = 20.78$ Hz). And they slightly change with time (!).

The importance of Schumann resonances





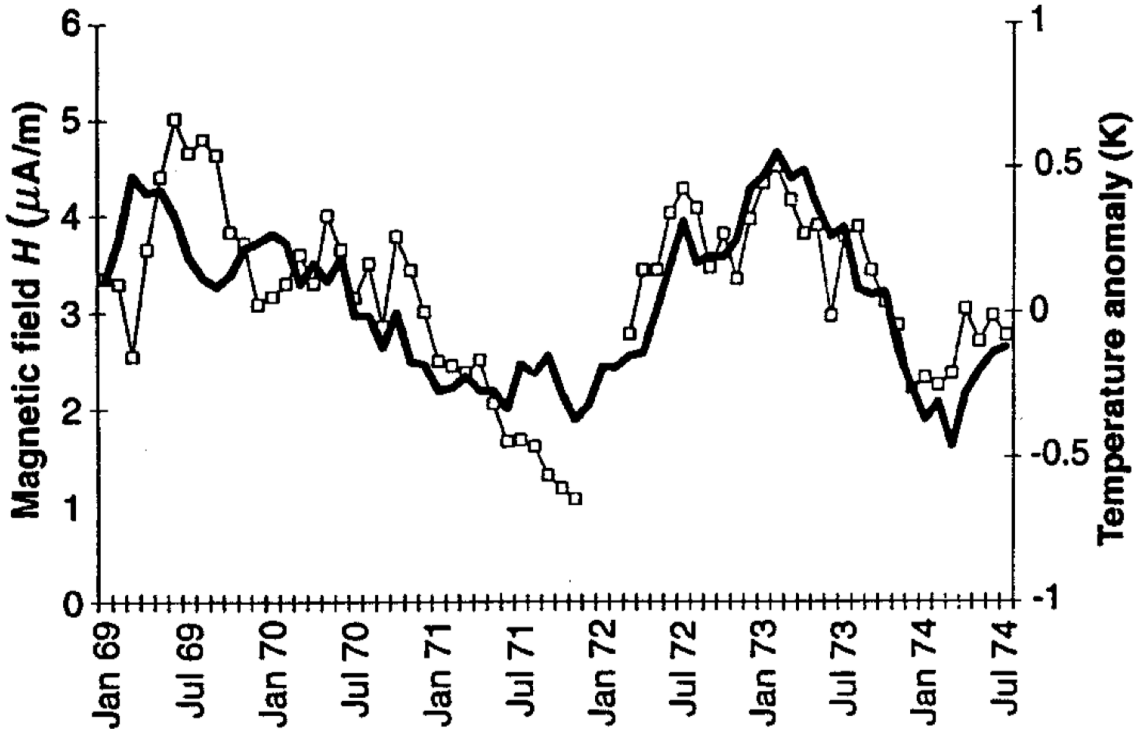
Schumann resonances are the principal background in the extremely low frequency (ELF) region of the electromagnetic spectrum from 3 Hz through 60 Hz.

LONG TERM MEASUREMENTS FROM THE MATRA GRAVITATIONAL AND GEOPHYSICAL LABORATORY

P. VÁN[1,5A], G.G. BARNAFÖLDI[1], T. BULIK[7], T. BIRÓ[2], S. CZELLÁR[3], M. CIEŚLAR[9], CS. CZANIK[2], E. DÁVID[1], E. DEBRECENI[1], M. DENYS[7], E. FENYVESI[3], D. GONDEK-ROSIŃSKA[7], Z. GRÁCZER[2], G. HAMAR[1], G. HUBA[1], I. KOVÁCS[2], R. KOVÁCS[1,5A], I. LEMPERGER[2], P. LÉVAI[1], S. LÖKÖS[2], J. MOLNÁR[3], NEHA SINGH[7], L. OLÁH[1,11], T. STARECKI[6], M. SUCHENEK[6], G. SURÁNYI[10], M. C. TRINGALI[7], D. VARGA[1], M. VASÚTH[1], B. VÁSÁRHELYI[5B] V. WESZTERGOM[2], Z. WÉBER[2], Z. ZIMBORÁS[1], L. SOMLAI[1]

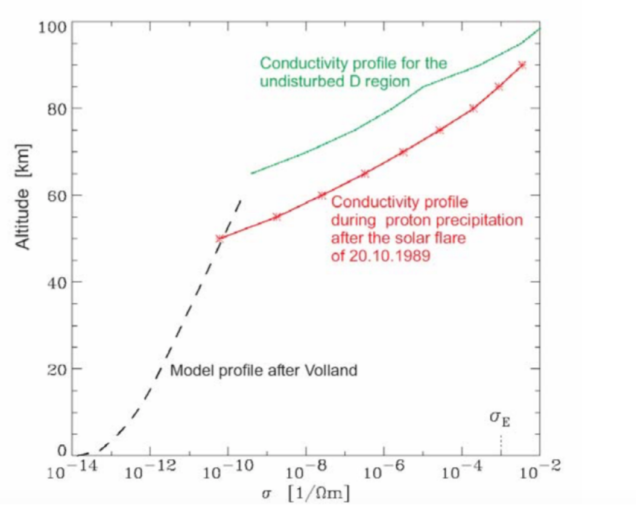
Abstract. Results of seismic, infrasound, electromagnetic noise and cosmic muon radiation measurements are reported in the underground Matra Gravitational and Geophysical Laboratory near Gyöngyösoroszi, Hungary. The collected seismic data of more than two years and two different devices is evaluated from the point of view of Einstein Telescope. The role of human noise and seasonal changes are analysed in order to understand the available lowest seismic noise level. We report also the test and observational data of the infrasound detector developed for underground operation and electromagnetic measurements in order to understand the underground effects of Schumann resonances. We show also the measurement results of our muon detectors, which provide direct information about the rock density distribution around underground locations.

Schumann resonances and weather



The amplitude of the first Schumann resonance and relative change in the tropical surface temperature (thick line). From Williams, E.R., *The Schumann resonance: A global tropical thermometer*, Science 256, 1184, (1992)

Schumann resonances and space weather



Conductivity of the ionospheric D-layer under normal conditions and after a solar flare. The raised conductivity changes not only the electric properties of the earth-ionosphere waveguide and thereby the Schumann resonance parameters, the upper boundary of the waveguide is also shifted downwards substantially by such events. From Schlegel, K. und M. Füllekrug, *Schumann resonance parameter changes during high?energy particle precipitation*, J. Geophys. Res. 104, 10111, (1999).