Correlation between X radiation measurements in the ionosphere and Schumann resonances observed in São Jose dos Campos - SP, Brazil

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Abstract - Using German-made SpectranNF-5035 RF sensors, spectrum measurements are carried out at frequencies from 1Hz to 40Hz on the ITA campus in São Jose dos Campos, Brazil. Schumann waves and their resonances were observed, which has been widely discussed from the theoretical point of view since 1956. However, few measurements of the relative peaks of resonances have been made until the present date, this is due to the very low value of the intensity of electric field detected here ~ 70 μV and magnetic induction intensity ~ 0.03 pT carried by it. Due to this dynamics their values of magnetic induction (B) and electric field (E) or electric potential (V) are influenced by variations in ionic density of the ionosphere. It is possible to obtain measured variations in the resonance of 7.8 Hz, between (0, 01 to 100) μV for electrical potential and (0.01 to 0.001)pT for magnetic induction. It was observed that through the waves measured between (1-40) Hz here on the Earth's surface, one can verify the greater or lesser degree of ionization of the terrestrial ionosphere. In that region on morning, it is possible to observe the low background value of Extremely Low Frequency (ELF) RF radiation.

I - Introduction

Non-ionizing radiation is generally the part of the electromagnetic spectrum whose energy is low to break atomic bonds. Among them are: ultraviolet radiation (λ> 200nm), visible light, infrared radiation, radio frequency (RF),(ELF), (VLF), (HF), (VHF) and microwave and Schumann waves in (ELF) frequencies[1]. This radiation has energy <12 eV (energy unit 1 eV = 1.602 x 10-19 Joules) and even when they are of high intensity, they cannot cause ionization in a biological system. However, it has been proven that these radiations produce other biological effects, such as: heating, alteration of chemical reactions or induction of electrical currents in cells. Schumann resonance are values of natural and stationary electromagnetic waves, with a wavelength the size of the Earth's circumference, which propagate in the resonant cavity between the Earth's surface and the ionosphere, beginningabout 110 km high [2].

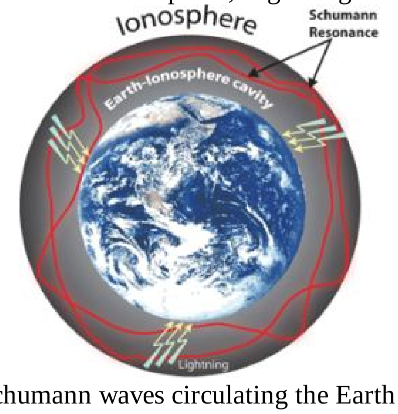

Fig. 1 – Schumann waves circulating the Earth planet [2].

Non-ionizing radiation are always present in the environment [3]. Electromagnetic radiation also consists of waves that propagate through space. These waves can be ionizing or non-ionizing radiation, are formed by composing an electric field (E), and induced magnetic field (B) which oscillates perpendicular to one another in the simplest case. The direction of propagation corresponds to the energy displacement (Poynting vector). These radiations include ultraviolet (near the visible), visible light, infrared, ELF (Extremely Low Frequency), LF (Low Frequency), VHF (Very High Frequency) and microwave. Some of this radiation is an electromagnetic spectrum band called Radio Frequency (RF) [4]. The alternating electric current also produces electromagnetic fields around the various conductors and equipment in any place in Brazil. For example, the oscillation frequency of the alternating current in Brazil is 60 Hz and its harmonics are as 120Hz, 180Hz, 240Hz and more. Between 1 Hz and 40 Hz (ELF) are naturally call Schumann waves determined by the resonances in 7.8 Hz, (14-16) Hz, 20.0 Hz and 33.0 Hz. Between (1-12) Hz, according to the recent theoretical work [4], waves formed in the ionosphere through HF wave and local ions interactions that can exist. These waves are extremely difficult to be measured given the low electric field values (E) and magnetic induced fields (B) by which they are transported [5].This experimental work shows measurements of these parameters performed in the region of São José dos Campos, Brazil. Schumann's resonances are observed because the space between the Earth and the level of ionosphere represents a natural cavity that acts as a waveguide. This cavity is naturally excited by variations in the electric and magnetic fields in the atmosphere such as those produced by lightning and other types of lightning strikes in all planet Earth [6]

II - Materials and Methods

Due to the extremely low values of electrical potential and magnetic induction field, few measurements of the relative peaks of resonances have been carried out until today. To monitor these resonances on the campus of the ITA (Aeronautical Technological Institute) in São José dos Campos, SP, a SpectranNF5035 sensor manufactured by the German company Aaronia AG was used, on a scale with a sensitivity of 0.1 nVolt[7].

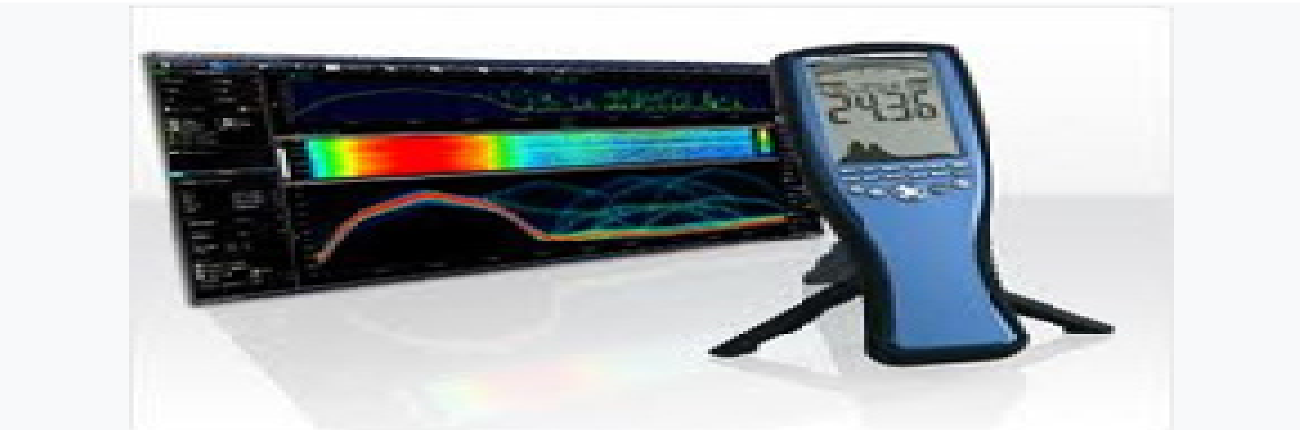

Fig. 2 – View of SpectranNF-5035 used to make the measurements shown in this work belonging to the author.

The spectrum of the monitored environmental energy was from 1 Hz to 40 Hz, a sampling time of 50 ms and a frequency bandwidth (RBW) of 0.3 Hz. This calibration was obtained after statistical treatment performed by the group; thus, resonances were observed at 7.8 Hz, 15.6 Hz, 20 Hz, and 33 Hz. We never seen the 27Hz resonance.

All details of the parameter settings and operation of the frequency spectrum analyzer can be found in the above-mentioned manufacturer’s website [7]. A laptop PC (Dell Vostro i5) it was used for the acquisition and determination of the frequency spectra with the measured data files. Because the system is compact and portable, it is possible to carry out surveys of non-ionizing radiation field at any remote location. Figure 3 shows the lifting of the electric field (V/m) environment at ITA campus in São José dos Campos, SP, Brazil. It was observed in this graph that the electric local transmission line on site (ITA campus) induces the electric field at 60 Hz and 120 Hz, showing the proper functioning of SpectranNF-5035 sensor[8].

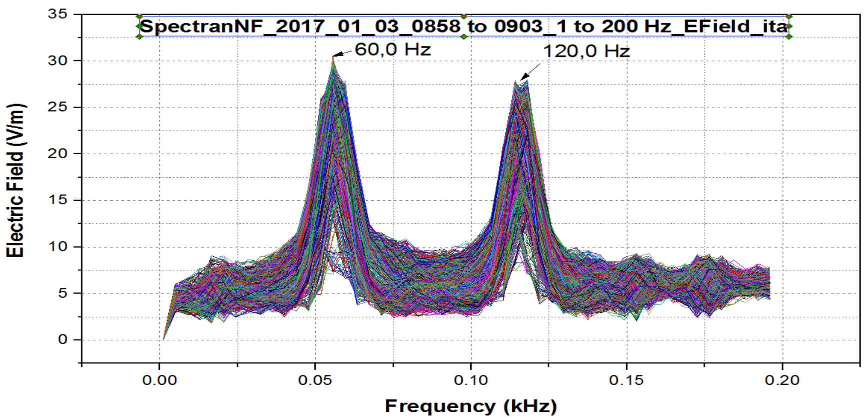

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Fig. 3 – Calibration of SpectranNF-5035 measuring electric field under local electric power line of 220V and 110V. The 60 Hz are the first frequency of transmissions line in Brazil giving maximum value of 30 Volt/m. Different colored lines corresponds to the number of samples taken during morning time [8].

The main data collection base is located inside the campus of the Department of Aerospace Science and Technology (DCTA) in São José dos Campos, SP (23 ° 12 '45 ”S, 45 ° 52' 20” W, alt. 620m) [9].

Fig. 4– Room inside and above the tower where SpectranNF5035 was located [9].

This area located in the DCTA is dedicated to scientific experiments that have a minimum of electrical and magnetic background noise, avoiding electromagnetic interference in the instruments.

III - Results and Discussions

For measurements taken in 2012to 2019, little variation in the signal strength in the resonances was detected, always being in the range between (0,01 to 100)μVolt in terms of electric potential. In this research, we tried to emphasize the study of 7.8 Hz resonance, since it is mentioned in several studies as fundamental for the balance in the mental and physical state of human body beings, that is, in some way not yet proven and little studied the Schumann waves are linked to the life of living beings on Earth [10].

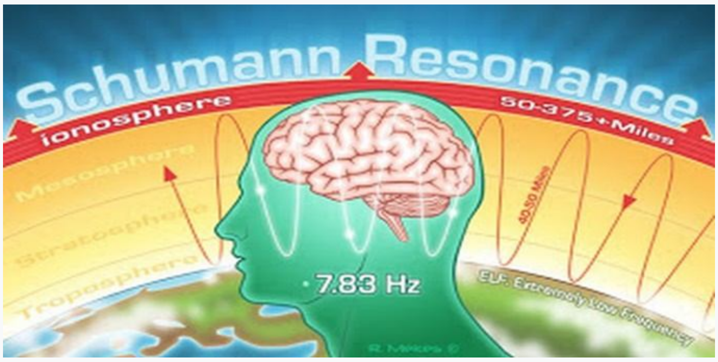

Fig. 5–Possible interference between Schumann resonance and human brain waves [10].

Monitoring Schumann resonances can provide important information regarding weather conditions, the state of ionization in the ionosphere and the atmospheric electric and magnetic field.Figure 6 shows the graph of the first measurement of Schumann's resonances taken on 11/7/2012 at the ITA campus in São Jose dos Campos, Brazil. The first peak of resonances measured at 7.8 Hz appears with 0.07 (μV) of electrical potential. The second peak is not well defined in frequency between (14-16) Hz with same potential electric value. The third very visible peak is centered at 20.0 Hz around 0.065 (μV) and the fourth peak located at 33.0 Hz with 0.05 (μV) of electrical potential.

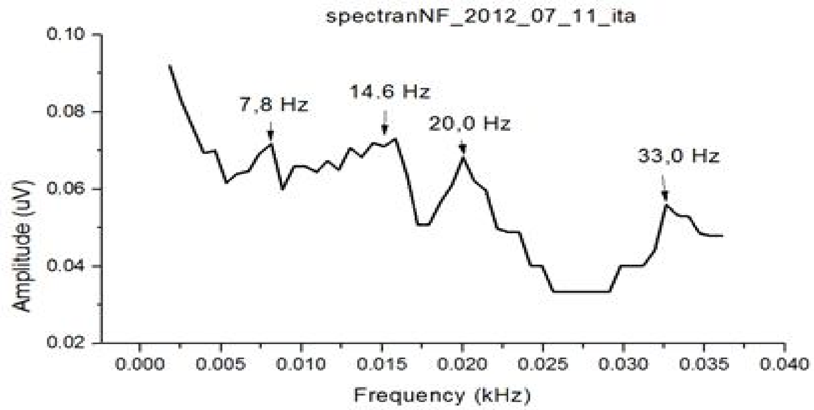

Fig. 6 – First measurement of Schumann's resonances done at ITA in 2012 between 07: 00-07: 05 local time (author).

As Schumann's resonances are closely related to, the production of lightning in the atmosphere and their monitoring can provide information regarding the amount and intensity of electrical discharges in function of time that occur in the atmosphere across the earth. In addition, they can measure the ionization index of the ionosphere via soft X-rays in the ionosphere (see last satellite Goesmeasurements) that produce a greater or lesser degree of ionization of the terrestrial ionosphere. In Figure 7 it is observed the clear resonance of Schumann measured at 09:00 local time hour.On that day and time, it was possible to measure the minimum level of RF radiation in ELF with Schumann resonances.

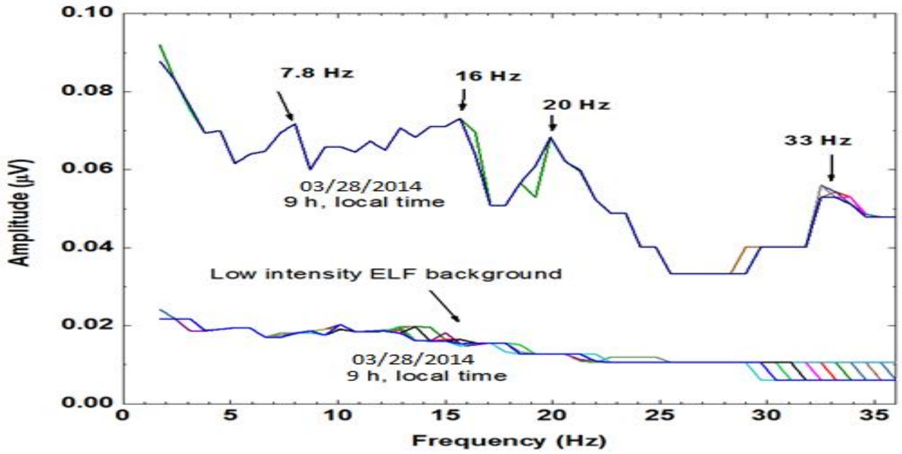

Fig. 7 – Background measurements and ionospheric effects in measurements of ELF on 03/28/2014.The different colors indicate different passages of measurement cycles (author)

In Figure 8 the measurements made on 08/12/2016 from the same location of the ITA are shown, repeating in the morning the effects of the ionosphere and with the background noise of the RF in ELF interval.

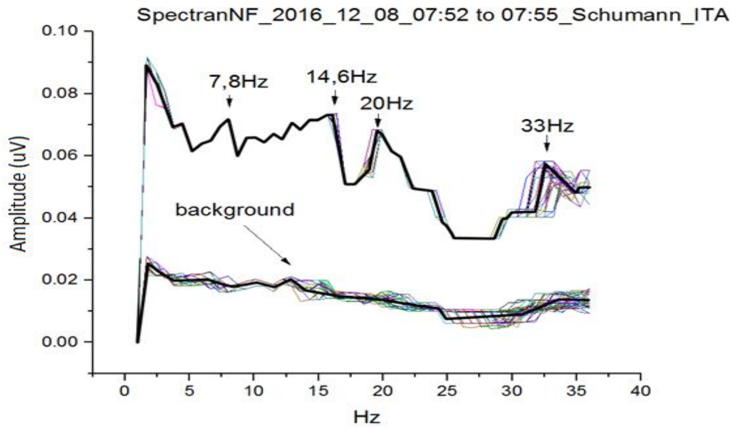

Fig. 8 – RF measurements in ELF on 12/08/2016, with different color curves showing different passages or cycles of RF radiation (author).

In Figure 9, measurements taken on the morning of 01/04/2017 are shown with the Schumann resonances and the background noise of the ELF radiation.

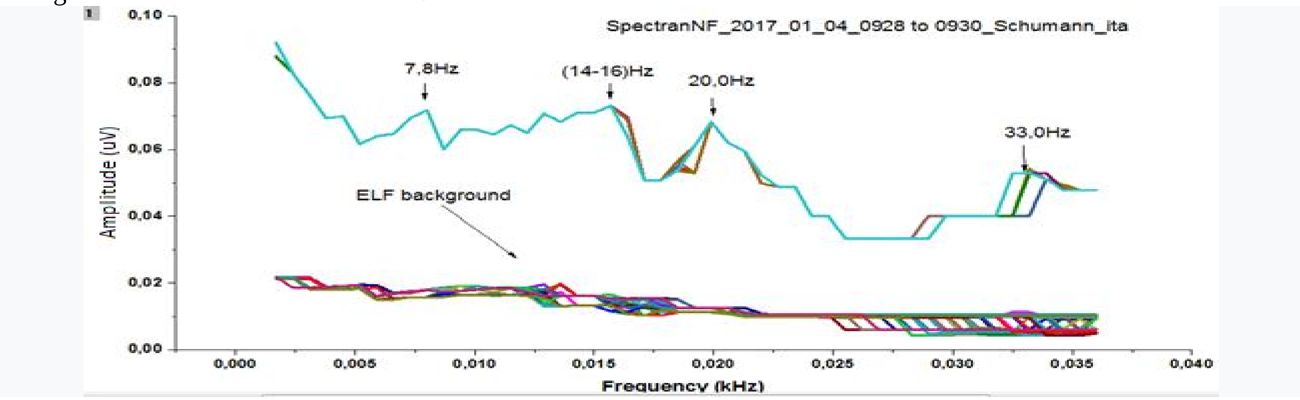

Fig. 9 - RF measurements in ELF on 04/01/2017, with different color curves showing different passages or cycles of RF radiation with resonances and background values (author).

Figure 10 shows the Schumann resonance measurements starting at 08:44 am local time, where the background noise of RF radiation in ELF does not appear.

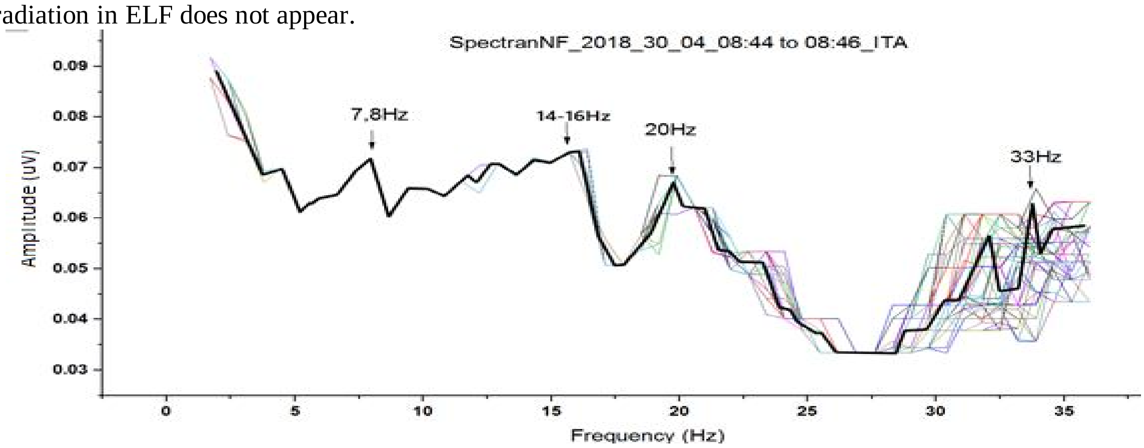

Fig. 10 - RF measurements in ELF on 04/30/2018 during morning period, with different color curves showing different passages or cycles of RF radiation only with resonances (author).

Note in Figure 11 below, measurements taken on 08/26/2019 also in the morning beginning at 08:41 am where only Schumann resonances appear.

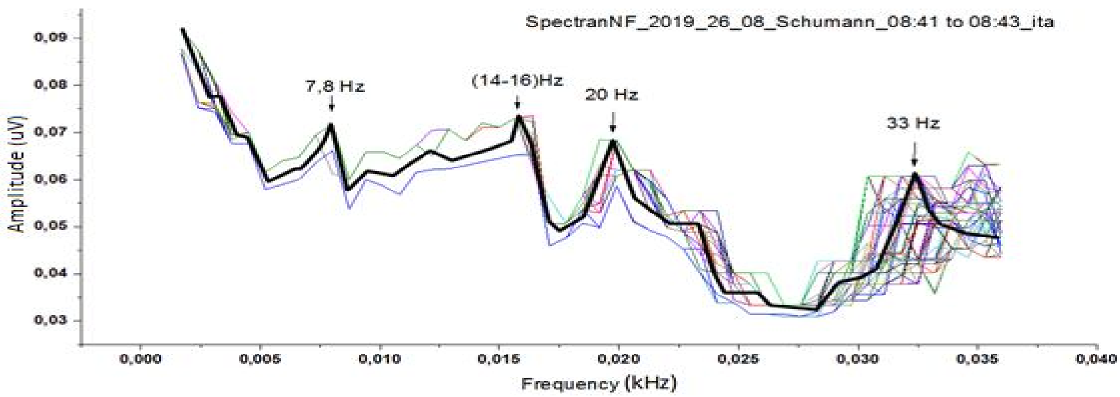

Fig. 11 - Measurements of Schumann resonances during morning period of 2019/26/08 showing absence of the (ELF background) and in vertical axe the Amplitude in (µV) of resonances (author).

Distinct color lines represents cycles during measurements times.

IV - Conclusion

From 2012 to 2019 years the maximum and minimum intensity of Schumann waves was measured always in the morning between 07:00 and 11:00 local time. The minimum was 0.008 (µV) and the maximum was 0.10 (µV) between 1Hz and 40Hz frequency. In the morning until 11:00 in local time, Schumann's resonances are clearly observed. After this local time you can only observe in general the local background radiation without the resonances with amplitude in µVless than 0,2. To carry out these measures, a special technique was developed by the author for the ELF antenna of the SpectranNF-3550 sensor. Local solar irradiation and the amount of lightning throughout the lower terrestrial atmosphere contributes to variations in the intensity of signals received from electrical potential (µV). The magnetic induction field ~ 0.02 (pT) was not possible to measure with this sensor whose magnetic intensity was within the possible limit of measurement (background noise). Every second, a multitude of pulses travel around the world in this unique, resonant chamber between the Earth and the ionosphere, sending colluding signals to all microorganisms. These signals couple us to the Earth’s magnetic field.

V - Acknowledgements

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