Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

HDS28-06 Room:312 Time:May 1 17:30-17:45

Observing Schumann Resonance by demodulating High Frequency Waves

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The limited dimensions of the Earth cause the waveguide between the surface of the Earth and the conductive ionosphere to act as a resonant cavity for electromagnetic waves in the ELF band so that Schumann Resonance (SR)occurs there. It has been suggested that SR may be used to monitor global temperature variations. SR has been used to study the lower ionosphere on Earth and suggested as one way to explore the lower ionosphere on celestial bodies. A new field of interest using SR is related to short-term earthquake prediction. The manmade noises in the ELF band was a problem for observing. A new way to observe SR based on cross-modulation in the low ionosphere is discussed.

The effect of cross-modulation was established by Yampolski et al. between SR and HF signals experimentally. The HF signals called Round-the-world signals (RWS) and large antenna arrays of the radio telescope UTR-2 were used. But the problem is whether the SR can be seen only with a simple antenna. If the answer is yes, we have a new measurement method for SR.

The HF-SR multiple mode nonlinear interaction theory is researched based on the basic theory model established. In the multiple interaction mode theory, the modulation depth is affected by electromagnetic wave phase in the nonlinear effect. Before the experiment, a lot of simulation experiments and theoretical research are carried out , including Schumann Resonance global distribution simulation and multi-mode interaction of HF-SR theory etc.. One simpler half wave cross dipole antenna is used to receive the time service signal of China called BPM. And in the demodulation spectrum of BPM, the first 4 order resonance peaks of the SR are obtained successfully, respectively on 7.5Hz, 14Hz, 20Hz and 26Hz.

The electric field distributions and phase variations of the firse 3 order peaks of Schumann Resonance in the earth ionosphere cavity are obtained through a series of SR distributed simulation experiments. The result shows that in the same phase region, the phase of SR only depends on time. At the same time all the points have the same vibration phase. Two points have 180 degree difference phase after a phase mutation point.

The actual multi interaction mode effect between RWS and SR is uncertain. It may change with the propagation conditions. The modulation depth can not be increased significantly in the multiple interaction effects of HF wave and SR propagate around the globe. The main reason is the high frequency wave goes through the the phase jump points of Schumann Resonance. The final depth of modulation in the Yampolski experiment is about 07-3.5 times to the modulation depth of single interaction.

RWS goes through around the earth. But the modulation depth of of RWS and SR nonlinear effect is not significantly far greater than that of 1 jump value because of the path length growth.

Using the RWS signal, greater modulation than short reception, for example, 1 hop, can be obtained. But due to the SR wave distribution in the earth ionosphere cavity, the value is less than the direct summation of each modulation results. That is to say, high frequency electromagnetic wave propagates around the earth for nearly a circle. It is modulation result with SR dose not significantly increase compared with that of the obtained by ionospheric reflection arrive at the receiving station.

According to the new theory of HF-SR interaction, a receiving station was established. The system receives the BPM time service signals from the National Time Service Center in PuCheng, 1160 km away from the receiver. The carrier frequency is 10 MHz. By demodulating the BPM signal, the first 4 order peaks of SR are obtained. Maybe it is a new way for SR observing.

Keywords: earth ionosphere cavity, Schumann Resonance, nonlinear effect, high frequency wave

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