ALFVEN CONTROL OF LONG WHISTLER ECHO TRAINS

Boris Ryabov, Nickolay Budko

IZMIRAN, 142190 Troitsk, Moscow Region, Russia. Tel: +7(095)-334-0903. Fax: +7(095)-334-0124.
E-mail: budko@izmiran.rssi.ru

ABSTRACT

The analysis of unique series of long odd whistler echo trains (8 trains) observed during 6 minutes ($1.9<L<2.8$) on board Intercosmos-24 shows that all trains are separated by the same dominant time interval 50-52 sec. The whistler wave propagation L-shell is found to be equal 2.4 for all trains. The appropriate Alfven wave propagation time for this L-shell is equal the same as the above separation time, i.e. 50-52 sec. These results suggest that observed long echo trains are controlled by Alfven waves.

The presence of field-aligned plasma density enhancement / ionization inhomogeneities is essential assumption for whistler wave propagation. These inhomogeneities provide quasilongitudinal whistler propagation and appropriate whistler dispersion observed in numerous experiments. However, the question about origin or formation of such density irregularities is not solved yet. The most reasonable seems hypothesis of duct formation as a result of thunderstorm electric field transport into plasmasphere (Park, Helliwell [1]). The duct formation time is 20 min – 3 hours. The shortest time corresponds to the larger electric field, which in turn corresponds to the larger cloud charge. The enter and trapping of whistlers in such duct should be identical for all whistlers excited by lightning. In particular, each lightning of appropriate symmetry (cloud – cloud, cloud – ground) could excite whistler echo train. These trains have to be independent each other under the conventional assumptions of duct mechanism of whistler guiding.

The purpose of present report is to show that echo trains are not independent but related each other and to find out a new specific features of echo whistlers. The analysis of unique series [2] of long odd order whistler echo trains (8 trains) observed during 6 minutes ($1.9<L<2.8$) on board Intercosmos-24 satellite revealed the following features:

1.The dispersion of all echo trains is described by

$$t_{n,m}(f) = \frac{(2n+1)D(f)}{\sqrt{f}} + t_{0,m} \,,$$

where n is whistler number in train and m is train number. $D(f)$ is weakly dependent on f, $D\approx77$, 76, 75 $s^{1/2}$ for f=4, 3, 2 kHz respectively and dispersion D is the same for all trains.

2. The whistler wave propagation L-shell estimated by standard method is found to be equal 2.4 for all trains. An equatorial electron density is found to be equal $n_e=1.8\cdot10^3$ cm^{-3}, rough estimate of Alfven wave propagation time for this L-shell (field line resonance period) gives 50-52 sec.

3. All trains are separated by the same dominant time interval ($t_{0,m+1}$-$t_{0,m}$) 50-52 sec, which coincides with Alfven wave propagation time.

These results suggest that observed long whistler echo trains are controlled by Alfven wave phenomena. It is probably that whistler echo train and Alfven wave forms the united coherent structure.

The comparison with few in number available experimental data shows that long echo trains registered under different geophysical conditions are similar each other: the ratio $t_{0,m+1}$-$t_{0,m}/D$ is the same with reasonable accuracy (≤10%). This similarity indicates on universal character of Alfven control of long whistler echo trains.

4. Additional interesting feature is the double structure of the initial whistler of every odd echo train: it consist of two whistlers separated by 0.2-0.36 s with different dispersion ($D\approx50$ $s^{½}$ for the first, faster whistler and $D\approx76$ $s^{1/2}$ for the second one being propagated with the same velocity as every whistler in echo train). Double structure of initial whistler seems to be inherent property of long odd echo trains. It was not emphasized in available papers, but this feature one can see in [3]. This double structure is not observed in even echo trains.

REFERENCES

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