

Proceedings of the Research Institute of Atmospheric,
Nagoya University, vol. 28(1981) -Activity Report-

Section 7. Magnetospheric Radio Emissions

The routine observation of VLF/ELF emissions has been carried out as before at Moshiri, by the minimum level reading method for hiss, at four frequencies of 0.8, 2.5, 5.0 and 8.0 KHz and by the method of wide band (0.5 - 8.0 KHz) recording on magnetic tapes for the discrete emissions as well as hiss. And the wide band observation has been continued at Sakushima also.

New receiving apparatus of VLF/ELF emissions with increased sensitivity by making use of cross-correlation method have been constructing at Moshiri and Kagoshima. For this purpose a large loop antenna was built in a valley near each station. The area of the antennas are about 4,500 m² and 6,400 m² respectively at Moshiri and at Kagoshima. Pre-amplified signals after receiving by these antennas are sent to each station, through an optical fibre cable of about 10 Km in length at Moshiri and by a 2 GHz microwave transmitter at Kagoshima. One of the main aims of this project is to detect such VLF/ELF emissions in regions of low latitude and low altitude as observed on board the Injun-3 satellite. It is expected to make clear the relationship between the emissions and energetic electrons or protons, injected into the plasmasphere and trapped in the radiation belts during or immediately after magnetic storms.

A new type of direction finder (DF) based on the measurement of arrival time differences between the master station and each of two slave stations was used to observe the azimuthal angle of auroral VLF hiss at Syowa Station, Antarctica in 1978 - 1979. A comparison of the DF results with ground based auroral data has indicated that impulsive auroral hiss of wide band frequency range has not emerged from the whole region of a bright aurora, but from some localized regions of bright electron aurora, and that the arrival directions of auroral hiss changed rapidly in accordance with the auroral movement. On the other hand, continuous auroral hiss dominated in the lower frequency range around 10 KHz and usually appeared associated with quiet auroras.

Some preliminary results obtained by the simultaneous observation of medium latitude VLF/ELF emissions at the two European stations,

Brorfelde in Denmark, Shambon-la-Foret in France during November 1978 through January 1979 have indicated four major categories of the emissions; (1) plasmopause-associated VLF emissions. (2) VLF hiss in the electron slot region, (3) periodic hiss and (4) periodic VLF emissions triggered in the hiss band.

In order to study a relation between the generation region of storm time VLF emissions and energetic electrons, we have calculated the trajectories of energetic electrons injected from the plasma sheet region at $L = 10$, in the presence of the corotational and K_p -dependent convective electric field and curvature- and gradient-B effects, and have compared the trajectory results with the Ariel-4 satellite data of VLF (3.2 KHz) emissions observed around 1.5 and 13.5 local time meridian during a moderate severe magnetic storm on 17 - 18 December, 1971. The results indicate that 0.1 and 1.0 Kev electrons in the plasma sheet region can reach just inside and outside regions of the plasmopause and their energy is increased up to a enough level to be resonant with the 3.2 KHz whistler mode wave. Where, the location of plasmopause is defined by tracing the trajectories of thermal electrons on the plasmasphere boundary and the results are satisfactorily compared with the plasmopause location data from the SSS-satellite on the dayside but on the night side a small correction, $+0.5L$, is necessary. As a future work calculations of growth rate and emission spectrum are intended by making use of energy and pitch angle distributions of energetic electrons which will be determined by the trajectory tracing method.

Change of kinetic energy of an electron in cyclotron interaction with whistler mode wave of constant frequency in the earth's magnetosphere has been calculated. And it is found that the combined effect of wave acceleration and geomagnetic field inhomogeneity is most contributive to reduce the electron kinetic energy, when the inhomogeneity increases during the interaction. As the reduced part of the kinetic energy of electron changes into the wave energy increase, the inhomogeneity can be said to play an essential role to amplify the transmitted VLF pulse of the ASE (artificially stimulated emission) experiment, which has been overlooked so far.

A collaborative work with University of Poitiers, France on whistler and VLF emissions has been continued, sponsored by the Japan Society for Promotion of Science.

March 4, 1981

- Jinsuke OHTSU -

Publications (1979-1981)

- Hayakawa, M., Y. Tanaka, M. Kashiwagi, J. Ohtsu and A. Iwai: Preliminary results on the direction finding for medium-latitude VLF emissions in Europe, Proc. Int'l Workshop on Selected Topics of Magnetospheric Physics, Tokyo, 380-386, March, 1979.
- Hayakawa, M., Y. Tanaka, A. Iwai, J. Ohtsu, M. Kashiwagi and T. Okada: Medium-latitude VLF/ELF emissions as deduced from the multi-stationed direction finding measurements, to be published in Memoirs Natl. Inst. Polar Res., Japan, 1981.
- Hayakawa, M., Y. Tanaka, A. Iwai, J. Ohtsu, L. R. O. Strory, C. Beghin and T. S. Jorgensen: Simultaneous spaced direction-finding measurements of medium-latitude VLF/ELF emissions, to be published in Planet. Space Sci., 1981.
- Nishino, M., A. Iwai, Y. Tanaka and T. Yamaguchi: Direction finding for auroral VLF hiss based on the measurement of the time difference among three spaced stations, Trans IECE, 63-B, 333-340, 1980 (in Japanese).
- Nishino, M., Y. Tanaka, A. Iwai and T. Hirasawa: A new direction finding technique for auroral VLF hiss based on the measurement of time differences of arrival at three spaced observing points: to be published in Planet. Space Sci., 1981.
- Nishino, M., Y. Tanaka, A. Iwai, T. Yamaguchi, T. Kamada and T. Hirasawa: A new direction finding system for auroral hiss in Antarctica based on the measurement of time difference of wave arrival at three spaced observing points: to be published in Memoirs Natl. Inst. Polar Res., Japan, 1981.
- Ohtsu, J. and M. Kashiwagi: An unusual VLF noise event observed at Sakushima on Sep. 29, 1978, Proc. Res. Inst. Atmos., Nagoya Univ., 26, 133-143, 1979.
- Tanaka, Y., M. Hayakawa, A. Iwai, T. Okada and J. Ohtsu: Multi-stationed direction finding measurements for medium-latitude VLF/ELF emissions, Highlights of the Japanese IMS Program, Nov., 1980, Inst. Space and Aeronautical Sci., Univ., Tokyo, 122-129, 1980.
- Yoshida, T., J. Ohtsu and M. Hayakawa: On the conditions of triggering VLF emissions by a natural whistler, Proc. Res. Inst. Atmos., Nagoya Univ., 27, 31-48, 1980.

