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Section 7. Magnetospheric Radio Emissions

Routine observations of VLF emissions and related phenomena have been continued at our observatories, Moshiri, Sakushima and Kagoshima. Temporal measurements have been made on the direction finding and polarization for VLF emissions. We are analysing the direction finding data for VLF/ELF emissions obtained by our European campaigns and the direction finding data of auroral hiss observed at Syowa Station, Antarctica.

In addition to the above passive ground-based measurement of natural plasma waves, we adopt two directions of research; (i). the direction finding for VLF/ELF waves on board spacecrafts for the elucidating their generation and propagation mechanism and (ii). study of wave-particle interactions by means of an active experiment. As for the first subject, we have carried out the direction finding for various types of emissions. Our recent wave normal analyses for chorus emissions aboard GEOS 2 have yielded that the lower band chorus ($f < f_H/2$, f : emission frequency, f_H : electron gyrofrequency) is electromagnetic, being generated by electron cyclotron instability, while the upper band chorus ($f > f_H/2$) is quasi-electrostatic whistler mode, and is generated by Harris type instability of lower energy electrons. Then, the wave normals have been determined for plasmaspheric ELF hiss, and it is found that their wave normals at the equator just inside the plasmapause make relatively large angles with the Earth's magnetic field, being very inconsistent with the previous theoretical implication. These oblique waves at the equator are expected to propagate into the inner plasmasphere, and to be observable at low latitude ground stations. This expectation has been confirmed by the polarization characteristics of ELF hiss as observed at Moshiri. The detailed theoretical studies for the generation mechanisms for both type emissions are in progress. The collaborative work on Arcad 3 project is being continued. Analyses of wave data over Japan have indicated the plasmaspheric ELF hiss is observed over a wide latitude range down to $L=1.2$ and its wave normals are successfully determined. An interesting phenomena of the Doppler broadening of VLF transmission signals and their associated side band structure have been recorded.

We will participate in the forthcoming satellite experiments, EXOS-D and Open in the field of direction findings.

As the first step of exploring the possibility of an active experiment at low latitudes, we have carried out the conjugate measurement on LF and VLF waves at Moshiri and its conjugate point, Birdsville, Qd., Australia. In order to examine, experimentally, the propagation characteristics of LF waves in the magnetosphere and ionosphere, we have made at Birdsville, the measurement of the signal intensity of magnetospherically propagated LF signals from DECCA and LORAN-C transmitters in Hokkaido. Furthermore, the simultaneous observation of VLF natural waves at Moshiri and Birdsville has been made, and an example of interesting results is the detection of VLF chorus emissions triggered by power line harmonic radiations probably from Japan and the associated ionospheric phenomena. Data are being analysed. During three months (June to September) of this year, we will carry out the more coordinated measurement than for the previous year. The most important inclusion is the reception of the magnetospheric VLF signals from the high-power Russian VLF transmitters, whose latitude is slightly higher than that of Moshiri, and their associated triggered emissions and precipitation at their conjugate points near Port Augusta are expected. The comparison of the properties of wave-particle interactions between LF and VLF would be of essential importance in the study of wave-particle interactions.

In order to incorporate with these experimental studies, theoretical studies have been started on the electron cyclotron resonance interaction between LF waves and electrons with quasi-relativistic energy in the inner radiation belt. And the test particle study has shown that quasi-relativistic electrons with very large pitch angles provide much more kinetic energy to the wave than non-relativistic electrons do. The theoretical consideration will be continued.

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Publications (1982-1984)

- Hayakawa, M., Y. Yamanaka, F. Lefeuvre and M. Parrot: Direction finding for chorus emissions observed by GEOS 2, Presented at AGU Chapman Conference on Waves in Magnetospheric Plasmas, Hawaii, Feb., 1983.
- Hayakawa M., Y. Tanaka, A. Iwai, J. Ohtsu, T. Okada, L.R.O. Storey, C. Beghin and T.S. Jorgensen: Direction finding for medium-latitude VLF/ELF emissions, *ibid.*
- Hayakawa M., Y. Tanaka, T. Okada, J. Ohtsu and A. Iwai: Conjugate measurements of LF, VLF, ELF and ULF waves at Moshiri and Birdsville ($L=1.59$): Rep. of STE Research Projects, Solar Terrestrial Environmental Res. Japan, 7, 12-16(1983).
- Hayakawa M., Y. Yamanaka, M. Parrot and F. Lefeuvre: The wave normals of magnetospheric chorus emissions observed on board GEOS 2, *J. Geophys. Res.*, in press, 1984.
- Hayakawa, M., M. Parrot and F. Lefeuvre: The wave normals of plasmaspheric ELF hiss observed by GEOS 1, to be submitted, 1984.
- Hayakawa, M., M. Parrot and F. Lefeuvre: The direction findings for VLF emissions on Geos, to be presented at Int'l Conference on Results of the ARCAD 3 project and of the recent programmes in magnetospheric and ionospheric physics, Toulouse, May, 1984,
- Hayakawa, M. and F. Lefeuvre: Direction finding on Arcad 3 of ELF waves at frequency below the proton gyrofrequency, *ibid.*
- Nishino, M., Y. Tanaka, A. Iwai, T. Kamada and T. Hirasawa: Comparison between the arrival direction of auroral hiss and the location of aurora observed at Syowa Station, *Mem. Nat'l Inst. Polar Res. Japan*, Special Issue No. 22, 81-90(1983).
- Nishino, M., Y. Tanaka, A. Iwai, T. Kamada and T. Hirasawa: On the observed results of the intensity and the polarization of narrow-band auroral hiss emissions: *ibid.*, No. 23, 81-90(1983).
- Tanaka, Y., M. Nishino, A. Iwai and M. Hayakawa: Direction finding of auroral VLF hiss, Presented at AGU Chapman Conference on Waves in Magnetospheric plasmas, Feb. Hawaii, 1983.
- Tanaka, Y. and M. Hayakawa: Doppler broadening of VLF signals aboard Aureole 3, to be presented at Int'l Conference on the ARCAD 3 project, Toulouse, May, 1984.
- Yamanaka, Y. and M. Hayakawa: Measurements of wave normal directions of magnetospheric VLF emissions observed on spacecrafts, *Trans. Inst. Elect. Comm. Engrs. Japan*, J66-B, 1428-29(1984), (in Japanese).
- Yoshida, T., J. Ohtsu and M. Hayakawa: A study on the mechanism of whistler-triggered VLF emissions, *J. Geophys.*, 53, 59-67(1983).

