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Section 7. Magnetospheric Radio Emissions

Routine observations of VLF/ELF emissions and related phenomena have been continued at our observatories, Moshiri and Kagoshima.

The data from our European VLF campaign are still being analyzed. The interesting characteristics of the frequency drift(mainly increase) of mid-latitude VLF emissions occurring at dawn sector,being associated with geomagnetic substorms, have been interpreted in terms of the velocity dispersion during the eastward longitudinal drift of energetic electrons after the injection around midnight. Recently,we are analyzing the VLF emissions in the pre-midnight sector,being again in close association with geomagnetic substorms. These premidnight emissions are characterized by their inverted V shaped frequency drift,which is being investigated. Furthermore,the VLF data obtained at Moshiri during one solar cycle have been utilized to have further understanding of mid-latitude VLF emissions. Especially,the local time dependence and the association with geomagnetic disturbances have enabled us to estimate the resonant energies of electrons responsible for the generation of unstructured hiss and structured VLF emissions. Also,the characteristics of whistler-triggered VLF emissions observed at Moshiri are being analyzed.

Direction finding studies for magnetospheric plasma waves on board spacecrafts have been continued in order to elucidate their generation and propagation mechanisms. Wave normals of plasmaspheric ELF hiss observed on GEOS 1 have been determined,which has yielded that the waves are generated by large θ angles on a majority of cases. The generation of very oblique waves is consistent with the ground-based polarization measurement at Moshiri(L=1.6). Next,ELF hiss in a detached plasma region of the magnetosphere has been found to be nearly field-aligned, and then the occurrence of hiss in such detached plasma regions has been found to be satisfactorily interpreted in terms of quasi-linear electron cyclotron instability. Further study on the wave normal directions of chorus is being continued. A lot of attention has been paid to

the study of half-gyrofrequency VLF emissions whose equatorial characteristics have been investigated previously by us. In order to obtain further understanding on these waves,the direction findings have been made at off-equatorial regions of the magnetosphere. With the help of inverse ray-tracings,it is confirmed that the upper band VLF emissions are half-gyrofrequency VLF emissions which are generated,at the equator,at frequency above one half the gyrofrequency,with wave normals close to the oblique resonance cone. This will support its generation by an electrostatic electron cyclotron instability we have recently proposed. We have just started the direction finding for hiss-triggered VLF emissions observed on GEOS 1 in order to study,in details,the wave-particle interaction processes. The generation of LHR noises observed on board a rocket at Syowa,has been discussed,based on the direction finding data. As a new project,the direction finding studies for geomagnetic pulsations observed by geostationary satellites,have been started by making full use of the techniques developed in VLF.

The collaborative work on Arcad project is being continued and we have discovered an interesting phenomenon. Doppler broadening of the transmission signals from Alpha VLF station and the associated sideband structures,have been observed on Aureol 3 satellite over Japan. Especially,those sideband structures have been confirmed,by means of the bicoherence analyses,to be resulted from the nonlinear coupling between VLF transmission signal and the existing ELF emissions. As an extension of this study,the Isis satellite reception of Siple signals is being planned in near future in collaboration with Stanford University,Radio Research Laboratory and some other groups.

As for the forthcoming Japanese satellite experiments,we are responsible for the measurement of electric fields by double-probe method and we are engaged in designing the antennas,the associated electronics, and the development of signal analysis system to be installed on EXOS-D and GEOTAIL satellites.

We have continued the study of wave-particle interactions along the line of active experiments. The conjugate measurement of the reception of whistler-mode signals from the Decca signals transmitted from Hokkaido,has been again made at the conjugate point,Birdsville,Qld,Australia and at some other points, in June-September 1986. The important difference for this campaign was the increase of the reception frequencies of Decca signals, the adoption of direction finding and the simultaneous observation at a few stations. Additionally,similarly to the observation in Australia,we have started the reception,at Kagoshima, of the whistler-mode signals from the Australian Decca trans-

mitter, in order to study the asymmetry(or symmetry) in the wave-particle interaction features. Moreover,as before,we have made the reception of whistler-mode signal and the associated triggered signals from a high-power Alpha VLF transmitter,at its conjugate point,Ceduna. The equipments to detect the particle precipitation due to the wave-particle interaction have been installed at several stations in Australia, based on the phase measurement of sub-ionospheric VLF propagation,and also simultaneous measurement of VLF/ELF natural noises and geomagnetic pulsations has been made. In order to incorporate with these experimental studies,theoretical studies have been continued on the cyclotron interaction between LF waves and electrons with quasi-relativistic energy in the inner radiation belt.

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