Simulation of Whistlers Observed in the Magnetosphere of Jupiter

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Radio Astronomy Explorer-1 (RAE- 1) data and high frequency ground based observations in the frequency range 300 kHz-40 MHz from Jupiter have been analyzed and composite power spectrum has been constructed. The measured power spectra were explained by considering synchrotron radiation from electron present in the Jovian ionosphere/ Magnetosphere. Recent observations of electromagnetic waves propagating in whistler mode in very low frequency range (1-10 kHz) is suggested to be generated during lightening discharge in the atmosphere of Jupiter. The detection of both whistlers and luminous spots by spacecraft Voyager 1 in 1978 are indicative of the existing of more power full lightning in the Jovian atmosphere than terrestrial lightning. Considering lightning discharge as a source current, we have developed a simulation technique to obtain dynamic spectra of electromagnetic waves in the wide- frequency range.

The waves generated in the atmosphere during lightning discharge propagate outward through the ionosphere and magnetosphere of Jupiter. The wave amplitude in the VLF frequency range gets attenuated during the course of propagation through the lower Jovian ionosphere, which is about 50 dB at night and increases to over 100 dB during daytime. Taking these informations into account, Maxwell's equations, continuity and momentum equations are solved together and an expression for wave electric field is derived. Fourier Transforms and inverse transforms are used to obtain wave field as a function of wave frequency, plasma frequency, gyrofrequency and distance. Transient lightning discharge current is represented by Dirac delta function. Computational technique has been developed and wave electric fields as a function of frequency for different medium parameters have been numerically computed.

The approximate value of the gyrofrequency in the lower Jovian ionosphere is 6.4 MHz which corresponds to 2.3×10^{-4} T [2]. This is ten times higher than that of the terrestrial ionosphere and hence the particle gyrofrequency will also be higher. Since whistler mode propagation is possible only in the frequency range lower than the gyrofrequency therefore, the observations of the whistler mode signal in the Jovian atmosphere should be made in the higher frequency range also, however observations has been made only in the range of 1-10 kHz. We have simulated the dynamic spectra of the whistlers and matched with the observed signals on board satellites. Since we have made computations in the lower frequency range the effect of the motion of the ions is also incorporated. Dispersion produced in signal depends on the distance traveled, plasma density distribution along the path of propagation and Jovian magnetic field model. The present study plays significant role in the interpretation of dynamic spectra of the observed signal and probing of the medium.

REFERENCES

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