R008-07
C 会場 ：11/26　 AM2 （10:30-12:00）
10:45～11:00

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Pitch angle diffusion coefficient of relativistic electrons using a matrix calculation in kappa-Maxwellian plasmas

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In the planetary magnetospheres, EMIC (electromagnetic ion cyclotron) waves play an important role in the energization and loss of magnetospheric plasmas. For instance, the pitch angle scattering through the cyclotron resonance with EMIC waves is a significant loss mechanism for the relativistic electrons in the Earth's outer radiation belt. The primary source for the generation of EMIC waves is a temperature anisotropy of energetic ions in the magnetosphere. This study focuses on the velocity distribution function of energetic ions to evaluate plasma diffusion coefficients of pitch angle scattering.

The conventional root finding approach for solving the plasma dispersion relations can only give one solution at one calculation root and depends on the initial parameters. To solve these calculation problems, we use a matrix approach, which can give all the important solutions of plasma dispersion relation by one matrix calculation without the initial parameters [1]. Our calculation results can give the plasma dispersion relations in bi-Maxwellian and/or kappa-Mawellian distributions for multi-species plasmas (ions and electrons). Then, we can calculate pitch angle diffusion coefficients of plasma particles using the calculated dispersion relation for EMIC or whistler-mode waves with the parallel or oblique propagations.

We evaluate the diffusion coefficients of relativistic electrons resonated with EMIC waves, under the assumption that 8% energetic H+ for both the distribution of the bi-Maxwellian and the kappa-Maxwellian for kappa = 4 and the cold plasmas of H+, He+, O+, and e-. The calculation result shows that there are large decreases in the diffusion coefficient for the relativistic electrons in few energy bands only for the case of the bi-Maxwellian distribution of H+. This difference is caused by zero points in the group velocity in the dispersion relation using the bi-Maxwellian distribution of H+. The reason for the zero points in the group velocity is that the bi-Maxwellian distribution is a higher temperature anisotropy than that for the kappa-Maxwellian distribution, even in the case of the same thermal velocity in both the distributions, and the dispersion relation is more highly bent.

The bi-Maxwellian and kappa-Maxwellian of hot plasmas are important for evaluating the pitch angle diffusion coefficient of plasmas in the planetary magnetospheres (e.g., Mercury and Jupitar etc.). Thus, the matrix calculation technique for both the distribution functions can contribute to the quantitative evaluation of the plasma diffusion processes. In this presentation, we will discuss the effects of energetic particles on plasma dispersion relations and the pitch angle diffusion coefficients in detail using the matrix calculation technique.

Reference
[1] H.S. Xie, "BO: A unified tool for plasma waves and instabilities analysis", Computer Physics Communications, 244, November 2019, 343-371, doi.org:10.1016/j.cpc.2019.06.014