RESONANT HEATING OF THERMAL IONS BY ELECTROMAGNETIC ION CYCLOTRON WAVES IN THE MAGNETOSPHERE

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Electromagnetic Ion Cyclotron (EMIC) waves are left-hand-polarized electromagnetic waves which are commonly observed at frequencies below the gyrofrequencies of different species ions. The anisotropic ion distribution in the ring current is unstable and potentially provides the free energy for the excitation of EMIC waves in the magnetosphere. The HOPE instrument and the EMFISIS instrument of the Van Allen Probes provided excellent observation opportunities for the study of the relation between EMIC waves and different species ions. Besides the association with the ring current ions, we found clear correlations between the hydrogen and helium band EMIC waves with the enhancement of trapped helium and oxygen ions at thermal energies near the outer edge of the plasmasphere, respectively. The observation indicated that as EMIC wave powers in hydrogen and helium bands increased, the pitch angle distributions of several hundred eV helium and oxygen varied from field-aligned to trapped distributions, respectively. Using the observed plasma wave properties and background plasma conditions, we analyzed the resonant interaction between EMIC waves and different species ions based on quasi-linear theory. The diffusion coefficients of different species ions due to different band EMIC waves were calculated, and the evolution of ion pitch angle distributions were simulated using UCLA diffusion code. Consistent with the previous studies, our calculation indicated that EMIC waves could cause pitch angle scattering loss of ring current ions from several keV to 100 keV. In addition, our simulation demonstrated the individual roles different band EMIC waves in resonant heating of different species ions. The helium ion heating was mostly caused by hydrogen-band EMIC waves, and the oxygen ion heating was mostly caused by helium-band EMIC waves. During the resonant heating process, the field-aligned thermal ions were accelerated to higher pitch angles and higher energies, forming the enhancement of trapped ions. Our study suggests the possible energy transfer from the EMIC waves to thermal ions in the inner magnetosphere.