Study on the Excitation Mechanism of Oxygen Ion Cyclotron Harmonic Waves in the Inner Magnetosphere Based on Observations

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Oxygen ion cyclotron harmonic (OCH) waves observed in the terrestrial magnetosphere have multiple spectral peaks at harmonics of the local oxygen ion cyclotron frequency. This study performs a linear kinetic instability analysis on a typical OCH wave event based on in-situ observations from the Van Allen probes. It was observed that the thermal oxygen ions have a partial shell distribution, which is approximated by the superposition of several ring-beam distributions. The results of the linear growth rate calculations show that the partial shell distribution of thermal oxygen ions provides free energy for the excitation of the observed OCH waves, with the maximum growth rate occurring at the third harmonic, corresponding to the peak frequency of the observed wave electric field power spectral density. Furthermore, by varying the proportion of cold heavy ions, the study also reveals that cold heavy ions damp the OCH waves near the corresponding heavy ion cyclotron frequencies. Specifically, an increase in the cold oxygen ion proportion dampens the second harmonic of the OCH waves, while an increase in the cold helium ion proportion dampens the fourth harmonic of the OCH waves.

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